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Implementation and Effects of India's National School-Based Iron Supplementation Program

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Abstract

Reducing the rate of anemia is a primary public health concern in many developing countries, where more than half of school-aged children suffer from the many serious consequences of childhood anemia. India has some of the highest rates of iron-deficiency anemia in the world and in 2013 implemented the national school-based Iron and Folic Acid Supplementation Program (IFASP) with the goal of reducing the prevalence and severity of anemia among school children. Although many highly controlled efficacy trials document the ability of iron supplementation to improve iron levels, there is little evidence about the best methods for providing supplements to large populations. This paper examines the tablet distribution patterns of the IFASP and its effects on children's iron levels. I use implementation data for 378 schools in five administrative blocks of Keonjhar District, Odisha to provide descriptive analysis of program implementation patterns and find that although the more advantaged blocks had the most universal tablet distribution, tablets were quasi-randomly distributed to schools within the less advantaged blocks. This variation in tablet receipt provides the framework to estimate the causal effect of the policy using a difference-in-differences strategy. My primary empirical finding is that the IFASP raised hemoglobin levels by 0.3 g/dL overall and had the largest effect on mildly anemic students and students who had received tablets most recently. This suggests that, though effective, school-based supplementation may not be sufficient to address high rates of more severe anemia and may be limited by non-optimal distribution and the constraints of a school calendar.

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Introduction

High rates of anemia, particularly in developing countries, are a major public health concern due to both the widespread prevalence of the micronutrient deficiency and its serious adverse effects on individuals and society. India has one of the highest rates of anemia in the world, and recently implemented a national school-based iron supplementation program to reduce the prevalence and severity of iron-deficiency anemia among school-aged children. This paper evaluates the national program in Keonjhar District, Odisha on two dimensions: the pattern of tablet distribution and the ability of the program to raise student hemoglobin levels.

Anemia is the most prevalent nutritional disorder in the world, causing irreparable damage to millions of individuals through poor health, early death, and lost wages (WHO 2015). In addition, there are social costs associated with high maternal and child mortality rates, economic costs associated with the treatment of iron deficiency anemia, and long term reductions in productivity due to low human capital attainment and poor physical health. Anemia is particularly harmful to children, causing cognitive and physical developmental delays and weakened immune systems, both of which have permanent effects. More than half of school-aged children in developing countries are anemic (ACC/SCN 2000; WHO 2001).

Rates of anemia are even higher in India, where anemia affects 60-70 percent of school-aged children. Anemia is also the most widespread micronutrient deficiency in the country (WHO 2008). In India, anemia is primarily caused by iron deficiency, a low concentration of hemoglobin in the blood often due to low iron intake or absorption, which has been shown to diminish physical growth, interfere with cognitive development, reduce concentration and increase lethargy – potentially impacting school attendance and performance (Gupta et al. 2012). While many efficacy trials have established that the additional intake of iron can reduce the prevalence of anemia and have other positive effects on physical health, nutrition, and cognitive development, it is unclear what policies are most effective at delivering iron supplementation to at-risk groups.

Policies that aim to increase iron intake across a population may have very different effects from the documented efficacy trials in which iron supplementation is largely regimented. On one hand, these programs are likely less efficient due to standard bureaucratic leakage and corruption, and even when individuals receive the supplements there is likely poor compliance. On the other hand, the community aspect of these interventions may magnify their effects if teachers and role models encourage changes in health behavior outside of the program or higher compliance with increased iron intake. Concrete evidence concerning the implementation and impact of large-scale iron supplementation programs is sparse – especially regarding distribution of the supplements and school, teacher, or student compliance with program guidelines.

To study the effect of India's national school-based Iron and Folic Acid Supplementation Program (IFASP) on student hemoglobin levels, I first examine the implementation of this program to understand why certain schools across five administrative blocks in Keonjhar got tablets and others did not over the 2013-2014 school year. In every block, all schools were supposed to receive tablets, but there was substantial variation in how many schools per block reported actually receiving tablets from the government.

In two administrative blocks, more than 95 percent of schools received tablets from the government. In the remaining three blocks, 48, 61, and 82 percent of schools received tablets, respectively. Comparing survey data across the blocks, I find that schools in the high distribution rate blocks are very different from schools in the remaining three blocks: they are closer to block headquarters, more likely to have sufficient water, and have a more effective and differently managed school lunch program. Additionally, they are located in villages with lower proportions of residents in a disadvantaged caste or with no formal schooling and higher proportions of residents who live in high-quality housing or own a phone. These blocks also have more anemic students and students with lower BMIs on average.

However, within each of the remaining three blocks that experienced less universal distribution of IFASP tablets, distribution of the tablets appears random. I focus on these blocks with variation in implementation, in which 70 percent of schools overall reported receiving tablets from the government. I examine which school characteristics and student demographics are correlated with receipt of the IFASP tablets and find that schools receiving IFASP tablets are in villages with higher proportions of residents in a disadvantaged caste and working in their own homes. However, conditional on block, I find no evidence of a systematic relationship between these correlates and IFASP implementation. The data support the conclusion that distribution of the tablets within blocks was quasi-random, likely because officials ran out of tablets before distributing them to all of the schools in their block. School heads suggested this reasoning during a survey about IFASP implementation. Officials may have run out of tablets in these blocks because they are more remote and the recorded number of tablets needed was less accurate than it was in the blocks closer to the district headquarters. This quasi-random implementation bolsters the identifying assumptions necessary to evaluate the effect of the IFASP on student health and cognitive outcomes.

Using this quasi-random variation in IFASP receipt, I examine the effect of the program in its first year in the three blocks with IFASP variation.[1] As per the program guidelines, children were meant to receive tablets of elemental iron (30 mg) at school for 100 consecutive school days, but the average number of tablets per student received from the government in these three blocks ranged from only 15 to 57 tablets per student. I first estimate a standard differences-in-differences (DD) model and find that attending a school that received IFASP tablets raises children's hemoglobin levels by a marginally significant 0.28-0.31 g/dL. This effect is within the bounds of expected effects of a program on this scale.

A potential challenge to this strategy is if students in schools that received tablets had hemoglobin levels that were trending differently from those of students in schools that did not receive the tablets over this school year. In that case, the DD model would mistakenly attribute those differences to the IFASP. In addition to showing that student nutritional markers and hemoglobin distributions were very similar in both types of schools within block, I address this concern by exploiting within-school variation in baseline hemoglobin status. Children with lower initial hemoglobin levels have been found to have larger hemoglobin gains with iron supplementation, since bodies more readily absorb micronutrients in which they are deficient (WHO 2001; Abrams et al. 2008). Thus, I expect students that are more severely iron deficient to gain the most from supplementation, and those that are not iron deficient to gain very little from supplementation. I find that the effects increase as baseline hemoglobin levels decrease and are largest for mildly anemic students, who experience significant increases of 0.842 g/dL. Moderately anemic students experience a smaller effect, suggesting that this type of policy may not be sufficient to persistently improve the hemoglobin levels of the

[1] At the time of the follow-up survey, children's hemoglobin levels were only measured in the three blocks with high variation in IFASP receipt.

most anemic students.[2] However, the fact that there is no effect for non-anemic students suggests that these findings are, in fact, the effects of the IFASP and not differential trends between treated and untreated schools.

Due to several timing discrepancies related to iron tablet distribution and hemoglobin measurement, I expect these results from the standard DD model to understate the true effect of the IFASP. I further exploit variation in the recentness and frequency of iron supplementation and show that the largest effects are concentrated among students who have received supplements the most recently, while students who received supplements less recently experience smaller effects. I use various measures and specifications to isolate this effect and find that students receiving tablets more recently experienced marginally significant effects of the IFASP on hemoglobin levels in the range of 0.41-1.2 g/dL.

Observational evidence concerning the implementation of this program may be applicable to understanding the distribution patterns of other centrally managed programs in India. While the magnitude of the empirical results presented here are obviously specific to a particular context (they depend on iron dosage, anemia prevalence and severity, compliance, etc.) they are some of the only estimates of the effects of a supplementation program implemented in the field. On the other hand, the general pattern of heterogeneous effects for different groups of students are likely generalizable to school-based iron supplementation programs in general.

My findings contribute to two strands of the literature. First, the descriptive results on IFASP implementation contribute to the literature on government programs. In less remote blocks with residents of higher socioeconomic status on average, Block Education Officers (BEOs) received enough tablets to distribute to every school. In poorer and more remote blocks, BEOs ran out of tablets before they completed distribution. However, within each of those blocks it appears that the BEO distributed tablets to schools quasi-randomly (i.e. there is no evidence of corruption or sub-optimal distribution). This suggests that government implementation of programs like the IFASP can effectively provide iron tablets to children through schools on a large scale if

[2] Anemia levels (mild, moderate, and severe) are determined by standard WHO cutoffs. See Appendix Table A6 for details. Fewer than 1% of children in this sample are severely anemic, so moderately anemic students are the most anemic in this sample (Hb between 8 and 11 g/dL). At baseline, 37 percent of the sample was moderately anemic. "Mild" and "moderate" anemia are both misnomers in the sense that there are serious health concerns associated with all degrees of anemia.

the proper number of tablets is provided for each block. Second, the impact of the IFASP on child health contributes to the nutrition literature by looking beyond the efficacy of increased iron intake and providing evidence for the efficiency of a large-scale supplementation program.

This paper is organized as follows. Section 1 describes background information on the general causes and consequences of iron deficiency anemia, anemia in India, and the IFASP. Section 2 surveys the existing literature on the effects of iron supplementation and the implementation of large-scale supplementation policies. Section 3 describes the data used in this analysis and Section 4A presents the empirical methodologies used to estimate the effect of the IFASP. Section 4B provides a descriptive analysis of the implementation patterns of the IFASP, which both supports necessary identifying assumptions and illustrates the elements of the IFASP that need attention in future years. Section 5 discusses the results of the empirical analysis and the final section concludes.

Section I: Background

A. Iron Deficiency and Iron Deficiency Anemia

Sufficient iron intake is necessary for normal biologic human functioning, particularly physical growth and cognitive development. Iron intake naturally occurs from dietary consumption of foods high in iron, but foods differ in the amount of iron they contain and its absorbability. Due to a differing bioavailability of iron in animal and non-animal products, regions with largely vegetarian diets tend to have particularly high rates of iron deficiency and iron deficiency anemia (NIH 2015). In addition, populations with high incidence of parasitic worm infections are at a particularly high risk of iron deficiency due to intestinal blood loss, which is a particular concern for school-aged children (Stoltzfus and Dreyfuss 1998).

Iron deficiency is defined by several different factors and is diagnosed on a spectrum, with the most severe cases of iron deficiency resulting in iron deficiency anemia. Iron deficiency anemia is defined as a hemoglobin level more than two standard deviations below the mean hemoglobin level in a healthy population of the same gender and age and living at the same altitude (NIH 2015). Anemia, however, can be caused by factors other than iron deficiency. Generally, fifty percent of anemia cases are due to iron deficiency but this varies by country and subgroup. In India, the majority of anemia cases are caused by iron deficiency (Gupta et al. 2012). This is not unexpected, given that most Indian diets are high in foods with hard-to-absorb nonheme iron and antioxidants that interfere with iron absorption, and low in animal products that contain more easily absorbed heme iron (WHO 2001). Other risk factors for anemia include other micronutrient deficiencies (especially zinc and vitamin A or C) and chronic or parasitic infections (worms).[3]

The effects of iron deficiency anemia on individual health range in severity. The functional deficits associated with low iron stores include gastrointestinal ailments, weakened immune systems, lethargy, and impaired cognitive and physical performance. In infants and children, untreated iron deficiency can cause psychomotor and cognitive abnormalities that persist throughout adulthood as learning and cognitive impairments (NIH 2015; WHO 2001). However, the long-term effects of iron deficiency on growth depend on context-specific factors like diarrhea incidence, other infections, or the age at which one became iron deplete (WHO 2001). In extreme cases, severe anemia is associated with an increased risk of mortality and contributes to 20 percent of maternal deaths (WHO 2015; de Benoist et al. 2008; Miller and Welch 2013). Additionally, high rates of anemia have high social costs and negative spillover effects on entire populations.

Given that iron deficiency is so widespread and costly to measure, the more effective attempts to ameliorate rates of iron deficiency target entire sub-populations with high rates of iron deficiency anemia. The serious negative effects of iron deficiency additionally justify this approach. Public health researchers argue that a country with greater than forty percent prevalence rates of iron deficiency anemia within any sub-population is experiencing a severe public health problem, and that virtually every member of the subpopulation is likely experiencing the negative effects of some degree of iron deficiency. The solution therefore includes universal treatment for the entire population sub-group (de Benoist et al. 2008; WHO 2001).

The mitigation of anemia on a national scale requires a well-developed nutritional policy with long-term and short-term goals and methods. The fortification of

[3] The IFASP includes a biannual deworming regimen with the goal of maximizing the effect of iron supplementation. Worms compete for the hemoglobin in the bloodstream; the most effective iron supplementation programs therefore also provide deworming medication (Stoltzfus and Dreyfuss 1998).

common foods (as is done in many developed countries) is the long-run goal to permanently reduce iron deficiency; however, this approach is expensive and hard to implement quickly, especially when subsistence agriculture is common. Supplementation programs are less widely effective and more costly, but easier to mobilize quickly (Horton 1999; Mason, Mannar, and Mock 1999; de Benoist et al. 2008; Stoltzfus and Dreyfuss 1998; Miller and Welch 2013).

School-based supplementation programs are often used in areas with high rates of child anemia. Advantages of a school-based program include: (i) it does not require building additional infrastructure and thus can be implemented quickly; (ii) teachers may serve as role models and encourage greater participation; and (iii) children who regularly attend school will receive supplements more regularly or frequently than if the supplements were distributed at a local health clinic (de Benoist et al. 2008; Stokols 1996; Anderman et al. 2009). On the other hand, disadvantages include: (i) it only reaches children enrolled in and regularly attending school; (ii) it is constrained by the political economy of the school and local or federal governments; and (iii) teachers and school heads may resent the use of their time to implement the program, especially if they are already overworked (Kheirouri and Alizadeh 2014; Stoltzfus and Dreyfuss 1998). This paper will examine the implementation and short-run effectiveness of a school-based iron supplementation program in India.

B. India's Iron and Folic Acid Supplementation Program (IFASP)

Iron-deficiency anemia is the most widespread nutritional deficiency in India today, affecting 70 percent of children under 5, 60-70 percent of school-aged children, and more than 60 percent of adolescent girls (Gupta et al. 2012; WHO 2008). In 2012, India's Ministry of Health and Family Welfare introduced the national iron supplementation program through schools to reduce the prevalence and severity of anemia among school children. Beginning in January 2013, the IFASP provided iron and folic acid tablets free of charge to all children and adolescents attending school. This paper will examine the implementation patterns of the supplementation program over 378 schools in 5 administrative blocks of Keonjhar District, Odisha, as well as the effects of the program on student nutritional markers using panel data collected from eight hundred students attending 157 schools in 3 of these blocks before and after IFASP implementation.

According to IFASP guidelines distributed by central and state government officials, iron and folic acid supplements and deworming medication are to be distributed free of charge to all students attending school. Children 6-10 years old should receive 30 mg of elemental iron and 250 mg of folic acid daily for 100 days out of a year, under supervision. Students are also supposed to receive tablets to take home with them over school vacations. The IFASP guidelines encourage teachers to also take the tablets as role models for students, promoting supplement consumption. One tablet of deworming medication is also to be administered to each child every six months. The federal government intended for all teachers and health workers to be trained to notice visible signs of severe anemia so that they could refer those students to local health centers for further treatment. Additionally, the federal guidelines suggest that teachers conduct monthly nutrition and health education sessions with their students.

Implementation of the program relies on government officials at all administrative levels. The central government's Ministry of Health and Family Welfare is responsible for policy formation and technical support at the national level. In Odisha, the State Drug Management Unit (SDMU) procures iron and folic acid tablets as well as deworming medication at the state level and distributes the medications to each district drug store. There, the Deputy Manager of Reproductive and Child Health prepares lists detailing how many tablets are to be distributed to each block.[4] The District Education Officer (DEO) then instructs the Block Education Officer (BEO) to acquire the medications as per the list prepared at the district drug store. Finally, the BEO is expected to supply all schools in his block with the correct number of tablets.

In each school, headmasters are expected to receive the tablets and to provide them to the teacher in charge of IFASP implementation. This teacher is instructed to keep a ledger of supply and distribution, and is responsible for providing tablets to two adolescent female prefects, who should distribute the iron and folic acid tablets to students. The central and state governments also intend to monitor compliance quite intensively, with IFASP implementation information added to the school health records along with information regarding the school lunch program, which is also heavily

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[4] The calculations for the number of tablets per block were based on the school health plan for 2012-2013, which included enrollment data. Each block was supposed to receive 100 tablets per child enrolled in grades 1-5. Keonjhar District was responsible for distributing 20.5 million tablets for students in grades 1-5 (Goverment of Odisha 2012).

monitored. Every month, the BEO is to monitor school compliance with both of the programs. A core committee at the district level will also monitor progress monthly, and a state committee will meet quarterly. While the central government intends every school to have an IFASP committee with the principal, lead teachers, student representatives, and a local health worker, the documentation from Odisha (the state in which the district I study is located) does not mention such a committee (Goverment of Odisha 2012; Gupta et al. 2012).

As with any government policy, there is substantial variation in state-wide, district-wide, block-wide and school-wide implementation of the IFASP. Within the set of schools chosen for this study, 95 percent of schools in two of the five administrative blocks received IFASP supplements, whereas only 70 percent of schools in the three other blocks received supplements. Even within schools that received the supplements, there was large variation in the number of pills that students actually received as well as variation in the timing of tablet receipt from the government. Studying these real-world complications and the resulting effect of the policy are important to understanding how government nutrition policy translates into changing health outcomes for at-risk populations. Furthermore, analysis of the distribution patterns of IFASP tablets (both across and within blocks) will likely be relevant to other government programs implemented by these government officials.

Section II: Literature Review

The research surrounding iron supplementation largely falls into one of two categories: efficacy trials and programmatic evaluations. The efficacy trials test the effects of increased iron intake, conditional on consumption of additional iron as a part of the treatment group or placebo as part of the control group. Compliance is highly monitored, and researchers play a key role in the distribution of supplements or fortified foods to the participants in the randomized controlled trial (RCT). These studies are valuable for their ability to inform policymakers of the potential impact of a supplement program under the best possible circumstances, i.e. 100% individual compliance. However, they are not sufficient to fully inform policymakers: to implement effective policy, policymakers will also need to understand how iron supplements or fortified foods can best be delivered to individuals at risk of iron deficiency and how to ensure increased iron intake among the target population. In that vein, several programmatic evaluations, often conducted as RCTs, provide supplements or fortified foods to schools, train teachers in distribution and monitoring of consumption, and report on outcomes surrounding school implementation as well as child health. These 'implementation outcomes' include potential limitations, like common side effects reducing compliance rates, as well as potential benefits, like the role of nutritional counseling in improving compliance rates.

This section will first examine the evidence from relevant efficacy trials illustrating the effect of increased iron intake and deworming treatments on the prevalence of iron deficiency and anemia and hemoglobin levels, as well as heterogeneous effects on different groups and the timing of these effects over the course of program implementation. I will then summarize possible limitations or advantages stemming from the application of iron supplementation programs in the field as they are outlined in theory and empirical evidence, detail the findings of the few evaluations of "business-as-usual" school-based iron supplementation programs, and discuss their implications for my analysis of the IFASP.

A. Efficacy Trials

Efficacy trials of iron supplementation and fortification consistently find a decrease in the prevalence and severity of iron deficiency, despite varying locations, target groups, prevailing rates of iron deficiency, iron-providing intervention methods, and length of intervention. In a study with a target population similar to the IFASP, Kumar and Rajagopalan (2008) use variation in school lunch preparation (at home versus at school) to establish a natural control group and find that hemoglobin levels rise on average for students eating school-prepared iron-fortified food over the course of a year, while hemoglobin levels fall on average for students eating their home-prepared food without any additional iron fortification. They estimate an effect of 0.55 g/dL increase in children's hemoglobin levels resulting from daily supplementation over the course of a year. A meta analysis of 55 RCTs estimates that the overall effect of iron supplementation is to raise children's hemoglobin levels by 0.74 g/dL (Gera et al. 2007).

Estimates of the effect on anemia prevalence are highly responsive to the percentage of the population with anemia at the outset of the trial. Studies with only iron deficient participants are likely to largely overstate the effect of iron supplementation for a population of both anemic and non-anemic children. Effects of supplement interventions on micronutrient deficiencies are largest for children who are deficient in that micronutrient and/or anemic at the outset of the study (Abrams et al. 2008). In a study of adolescent girls in Malaysia, Tee et al. (1999) find that after three months of supplementation, the hemoglobin increase in anemic girls is twice the hemoglobin increase in borderline-anemic girls, likely due to a higher rate of iron absorption in anemic children due to their larger deficiency. In fact, changes in hemoglobin status after 1-2 months of iron supplementation can be used as a marker to diagnose iron deficiency, since changes are often only substantial among highly iron deficient individuals (WHO 2001). Across a variety of efficacy trials, the effect of iron supplementation on iron content in the blood ranged from 0.95-1.8 g/dL for anemic children (Hirve et al. 2007; Ahmed et al. 2010; Tee et al. 1999; Gera et al. 2007; Abrams et al. 2008) and from 0-0.5 g/dL for non-anemic children (Hyder et al. 2007; Gera et al. 2007).

In addition to these heterogeneous effects by initial iron status, these efficacy trials highlight potential interactions between iron supplementation and the provision of deworming medication. Deworming alone has a positive effect on many standard nutritional markers, and has larger effects in subgroups of children with high worm loads (Ebenezer et al. 2013). In general, deworming has no effect on hemoglobin levels; in the case of anemic children with very high worm loads, deworming alone may have a small positive effect on hemoglobin levels (Taylor-Robinson et al. 2012; Beasley et al. 1999).

Many studies also examine the potential benefits of providing multiple micronutrients rather than just iron or iron and folic acid, since many children are often deficient in more than one micronutrient. In general, multiple micronutrients are equally or more effective when compared with just iron supplementation or iron supplementation with folic acid (Miranda et al. 2014; Ahmed et al. 2010; Ramakrishnan et al. 2004). Folic acid is commonly given in conjunction with iron supplementation, as it is in the IFASP, since it stimulates the absorption of hemoglobin, and most studies evaluating multiple micronutrient supplementation compare to supplementation with iron plus folic acid (Tee et al. 1999). Given that iron deficiency is the main cause of anemia in India, it is possible that the IFASP has the potential to significantly reduce anemia rates. However, if the children do not have enough of the other micronutrients needed to adequately absorb the additional iron (for example, Vitamin C), the effect of the IFASP may be limited (NIH 2015). In countries where Vitamin A or Vitamin D deficiencies are the main cause of anemia (e.g. Vietnam and Korea, respectively), there is evidence to suggest that more than just iron supplementation is required to reduce anemia rates (Nguyen et al. 2012; Lee et al. 2015). One exception is the combination of iron and zinc, micronutrients which have been shown to inhibit the absorption of one another when present in high levels (Abrams et al. 2008). Overall, there is evidence to suggest that while the IFASP has the potential to reduce anemia rates, there are several factors that may inhibit its effectiveness.

Another consideration to keep in mind when measuring the effect of iron supplementation is timing effects. While Falkingham et al. (2010) hypothesize that more time may need to pass to see cognitive effects, the positive effects of iron supplementation on hemoglobin concentration occur early on in the trial and plateau after many months of supplementation as participants become iron sufficient and their bodies become less absorptive of iron (Hyder et al. 2007; Tee et al. 1999). Additionally, the measurable effect of iron supplementation may decrease relatively quickly after supplementation ends. On average, red blood cells survive in the blood stream for up to 120 days. When a red blood cell is produced, iron is transferred from storage in the spleen, liver, or bone marrow and attached to the future red blood cell (OpenStax 2013). Therefore it may take 3-4 months to see the effects of iron supplementation on hemoglobin levels in the bloodstream and similarly, the effects on measureable hemoglobin levels may decrease several months after active supplementation ceases.

In summary, most of the efficacy trials done to date show that increased iron intake, with or without other micronutrients, is most often beneficial or does no harm. There have been positive effects found on hemoglobin levels and iron storage; generally, the effects are strongest for individuals who are anemic or iron deficient at baseline. However, most of these studies are quite small in size, short in duration, and include a substantial amount of researcher control over consumption of supplements and adherence to the program. While they do offer causal interpretations due to their randomized design, they tell us little about the implementation of real-world nutrition policies to combat iron deficiency and anemia. In order to implement the most effective policy, we need to understand the implementation of supplementation efforts in the field, in addition to the scientific effect of iron consumption. The success of large-scale iron supplementation programs depends on the effectiveness of the delivery system.

B. Programmatic Evaluations

There are at least two possible limitations that could reduce the effectiveness of the IFASP: bureaucratic corruption and leakage within the system, and minimized compliance due to mistrust or dislike of the supplements. In order to be effective, the tablets first need to get to the target population. In the case of the IFASP, the supplement tablets need to get to schools and then to children. The distribution of tablets, though well planned by the government, will take substantial time and incur considerable transportation and other infrastructure costs. In 1989, UNICEF provided India with millions of iron supplements to disburse to local health clinics and deliver to pregnant and lactating women. The state of Gujarat received millions of supplements, but they were poorly distributed to each health clinic, limiting the potential impact on health (Gillespie, Kevany, and Mason 1991).

Even if the supplements get to the schools, the IFASP requires principals and teachers to commit to the program and distribute the tablets. These are not health professionals, and while the central government commits to training educators in the distribution of tablets, knowledge of side effects, and recognition of severe anemia, there is no guarantee that teachers and principals will distribute the tablets as instructed. In addition, iron supplementation can be harmful for people with untreated malaria and other diseases that require iron for replication of the infectious agent (WHO 2001). Teachers and principals may not be aware of these dangers. Stoltzfus and Dreyfuss (1998) also highlight potential losses due to structural, social, or political barriers to full commitment on the part of the distributors – in the case of the IFASP, teachers may resent the loss of class time spent on supplement distribution. Kheirouri and Alizadeh (2014) evaluate the reasons that Iran's national school-based iron supplementation program failed to have its intended effect on anemia prevalence. While the program asked teachers to take the iron pills in the classroom with students, 70 percent of the teachers in surveyed schools did not. Furthermore, 32 percent of teachers found the distribution of supplements in the classroom disruptive. If teachers do not commit to the IFASP, it will have a less than optimal effect on the prevalence of anemia and iron deficiency.

The second limitation facing an iron supplementation program a school environment is student compliance. The intake of iron supplements has potential side effects, which, while not harmful, can be relatively uncomfortable or unappealing. The efficacy trials detailed above all reported greater than 95% compliance because researchers closely monitored the consumption of iron supplements. Even if every student were to get iron supplements as planned as part of the IFASP, there is little assurance that each student actually consumed the tablets, and consumed the tablets as frequently as intended. Compliance will likely be much less than 95 percent. Kheirouri and Alizadeh (2014) measure compliance with the guidelines of Iran's national iron supplementation program: 62 percent of students reported full compliance and an additional 10 percent reported intermittent compliance, with these numbers likely over reported. Reports of programmatic evaluations (RCTs that delivered supplements to schools and observed teacher-led distribution and monitoring) report compliance rates ranging from 50-90 percent in Indonesia, near 100 percent in rural China, and 80 percent in Sri Lanka; however these rates are likely both over reported and positively influenced by random compliance checks researchers made to schools (Bloem et al. 2004; Luo 2012; Ebenezer et al. 2013). A district-wide iron supplementation program in Uttar Pradesh, India, found that compliance improved with additional counseling on the possible benefits of iron supplementation (Vir et al. 2008).

Any school-based iron supplementation program is going to face these potential challenges. While there is little evidence surrounding the implementation of large-scale policies, several RCTs (randomized at the school level) have evaluated the effectiveness of teacher-distributed iron supplementation programs. Compliance with these programs was not universal, even though they did not face the additional limitations of a government-to-school distribution chain that the IFASP faces. In general, RCTs with higher reported compliance rates find reduced prevalence of anemia and iron deficiency and improved knowledge of anemia (Luo et al. 2012; Vir et al. 2008). Other programs found no effect on anemia or iron deficiency prevalence and attributed the finding to poor compliance (Bloem et al. 2004; Ebenezer et al. 2013). The study most generalizable to the IFASP was a district-wide implementation in Uttar Pradesh, India. A pre-post evaluation found that over four years, the overall prevalence of anemia was reduced from 73 percent to 25 percent with weekly supplementation in schools (Vir et al. 2008). The IFASP was, in part, modeled on this program.

The results reported below expand on the evidence from efficacy trials by providing estimates of the effect of a large-scale iron supplementation program on children's hemoglobin levels in a real-world context, and, given the low levels of monitoring in the IFASP, offers more generalizable findings on both compliance and hemoglobin level effects than the existing programmatic evaluations. In addition, the programmatic evaluations described above randomize iron supplementation at the school level and thus cannot offer information about the patterns of distribution from the central government to schools. While the study by Vir et al. (2008) offers many of these descriptive results in a similar large-scale context, those authors do not provide plausible causal estimates of the effects on hemoglobin levels and anemia rates. My contribution to the literature is to combine the descriptive analysis of a program's implementation (following tablet distribution from the district to the schools and analyzing teacher and student compliance) with internally valid estimates of the effect of iron supplementation on children's hemoglobin levels.

Section III: Data

A. Timeline and Sample Selection

The data I am using for this project were collected in Keonjhar District, Odisha, between 2012 and 2014 as part of a randomized controlled trial (RCT) studying the effects of school lunch fortification on children's health and schooling outcomes. NGO partners were already operating in Odisha building a kitchen from which to distribute cooked meals to schools. The primary investigators obtained a list of schools in the region from the local government and narrowed the sample down to schools within the vicinity of the NGO's kitchen. The research team then approached the schools and randomly selected students from the roster of each school. Three "study children" were randomly selected from each grade (1-5) in the school, and their households were then approached for participation in the study. The baseline survey for the RCT was completed in October 2012 and included a school demographic survey, a household-level survey with detailed demographic questions about every family member of the study child, and anthropometric measurements for every child in the household. These measurements include height, weight, mid-upper arm circumference (MUAC), and hemoglobin levels. In the baseline survey, study children also completed a round of cognitive testing and math and reading tests.

In January 2013, following the completion of the baseline survey, the central government of India announced and implemented the IFASP, described above. The RCT studying school lunch fortification was put on hold, given the potential for adverse interactions between the two interventions. A year and a half later, in the spring of 2014, the researchers conducted an uptake survey to gauge the coverage and implementation of the IFASP. This school-level survey asked detailed questions about IFASP receipt from the government and distribution of the supplements to students attending school. The results from this uptake survey showed variation in IFASP implementation at the school level, but only for 3 of the 5 administrative blocks. A midline child-level survey was completed in the summer of 2014 in schools in these 3 blocks, which collected the same anthropometric measurements collected at baseline for study children and their siblings.[5] Due to budgetary constraints, only half of the study children were surveyed at midline. In the final panel dataset, there are 734 study children with data at baseline and midline – approximately 2 children per grade per school. For a detailed timeline of survey and implementation dates, see Figure 1.

These baseline and midline surveys are the key to the analysis in this paper, as varied IFASP implementation took place among schools in the sample in the time period between the two surveys. I exploit this natural variation in implementation to examine the effect of the IFASP alone on child anthropometric outcomes. The results indicate that this variation is not correlated with school and household characteristics, conditional on block fixed effects, supporting the parallel trends assumption of a differences-in-differences model.

B. Sample

To understand variation in the implementation of the IFASP, I use 378 schools sampled from all five blocks in Keonjhar District; of those, 157 schools are located in blocks that experienced variation in IFASP implementation. For each school I observe a range of demographic information (both school-reported and aggregated from

[5] The original RCT intervention was implemented in the following 2014-2015 school year, and an endline survey was conducted in the spring of 2015. The endline data is not used the analysis presented in this paper.

household reports), details on implementation of the school lunch program, as well as school-reported measures of IFASP implementation. Table 1 contains a full set of summary statistics on village demographics and school characteristics for each block. In general, the blocks that experienced variation in IFASP implementation are located in poorer and more rural areas. While this may impact the generalizability of this analysis, it does not affect the plausibility of the empirical strategy.

The dataset used to study the effect of the IFASP on child nutrition includes 734 study children attending schools in the blocks with variation in IFASP implementation that were sampled at baseline and midline. The dataset contains height, weight, MUAC, and hemoglobin concentration measurements for each student before and after the IFASP implementation, as well as a thorough set of household and individual demographic characteristics. Approximately two-thirds of the children attend schools that reported receiving supplements from the government, while the other one-third attends schools that reported not receiving the supplements.

The federal Ministry of Health and Family Welfare introduced the IFASP on a national scale to address the very high levels of anemia in the school-age population. In Odisha, more than 70 percent of school-age children are anemic. In this sample, more than half of the children tested at baseline present some level of anemia, and a third suffer from moderate or severe anemia. In addition, this is a very poor population: more than 92 percent of households belong to a disadvantaged caste, and only three-quarters of schools have sufficient drinking water.

C. Measures of IFASP Implementation

In the sample of three blocks with variation in IFASP implementation, 111 schools (70 percent) report receiving IFA tablets from their Block Education Officer (BEO) and 46 schools do not. Within the schools that received the tablets, there is additional variation in whether or not the school held IFASP teacher training, whether the school received deworming medication, and the number of tablets per student a school reports having received.[6] Of the 111 schools that received IFASP tablets, 96 also

[6] In schools that did not report the number of tablets received, the measure was replaced by the number of tablets schools reported distributing. Schools report receiving between 0 and 150 tablets per student and distributing 0 to 100 tablets per student. The correlation coefficient between these two measures is 0.5403.

received deworming medication; of the 46 schools that did not receive IFASP tablets, 38 also did not receive deworming medication. Additionally, 89 percent of schools that received IFA tablets expected more to be delivered, and the most common reason that schools gave for why they didn't get the tablets (other than 'don't know') was that the BEO ran out of tablets.

As part of the school uptake survey, three children per school were randomly selected to answer several questions about the IFASP implementation in their school. For each school, I calculate the percent of those three children that reported receiving tablets daily and receiving tablets the day before the survey. In blocks with variation in IFASP implementation, there were substantial differences between school-reported measures and child-reported measures. In schools that reported receiving IFASP tablets, only 58 percent of schools had at least 2 out of 3 children reporting daily distribution. Only 24 percent of schools reporting IFASP receipt had at least 2 out of 3 children reporting that they received tablets the day before the survey.

In addition, school headmasters report whether or not they have already run out of tablets (ran out, did not run out, or uncertain) at the time of the school uptake survey. In the sample of schools in blocks with high variation in IFASP implementation that did receive tablets (111 schools), 39 schools report running out of tablets, 25 report still having tablets to distribute, and the remaining 47 are uncertain. Based on these reports as well as the dates that schools reported receiving tablets and the number of tablets received per student, it is clear that all schools either: (a) ran out of tablets at least two months before children's hemoglobin levels were measured, if they were distributing tablets daily; (b) did not distribute the tablets as frequently as they were instructed; or (c) some combination of the two. Therefore the responses from the three randomly selected children (whether they received tablets daily or the previous day) at the time of the school survey (about two to four months before hemoglobin levels were measured) communicate information about the frequency and recentness of supplementation, respectively.[7]

[7] 46 schools report the actual date that they ran out of tablets, the date they received tablets, and the number of tablets per student. I use these measures and other school characteristics to generate a predicted run-out date for each school, which ranges from 250 days before the school survey to 250 days after the school survey. As expected, schools with students reporting daily distribution run out of tablets earlier and those with students reporting that they distributed tablets the previous day run out of tablets

This variation in IFASP implementation across schools allows for the analysis of the program using a difference-in-differences strategy, comparing the changes in hemoglobin levels for students who experienced the program and those who did not. As mentioned above and discussed in detail below, this strategy rests on the assumption that students' health outcomes in schools that received IFASP tablets would have trended similarly to those of students in schools that did not receive IFASP tablets in the absence of the program.

Section IV: Empirical Strategy

A. Effect of the IFASP

The main analysis in this paper will use a difference-in-difference (DD) model comparing the change in hemoglobin levels for children who experienced the program relative to students who did not, or children who experienced a more intense implementation compared to children with a weaker implementation. This specification takes the form:

$$\mathbf{Hb}_{ist} = \beta_0 + \beta_1\mathbf{IFASP}_s + \beta_2\mathbf{post}_t + \beta_3(\mathbf{IFASP}_s \times \mathbf{post}_t) + \varepsilon_{ist} \qquad (1)$$

where **Hb** is the hemoglobin level of child *i* in school *s* at time *t*, **IFASP** is a marker of IFASP implementation (an indicator for reporting the receipt of IFA tablets), and **post** is an indicator for whether hemoglobin measurement was taken after IFASP implementation. Additional control variables include the distance from a school to block headquarters, whether or not a school has a kitchen, the percent of parents satisfied with implementation of the school lunch program, the percent of families per school employed in housework outside the home, and the percent of families per school in a non-disadvantaged caste. In the preferred specification with school fixed-effects, these control variables are interacted with the **post** indicator. Additional specifications include an indicator for whether or not a school received deworming medication from the government, an interaction of that indicator with **post**, and an interaction to capture the joint effect of IFASP receipt and deworming receipt. In order to infer that β_3 is the causal effect of the IFASP, we assume that the health indicators of students in both IFASP and non-IFASP schools would have been on the same trend in the absence of the

later (Appendix Table A1), indicating that these student reported measures do contain some signal about implementation and are not entirely noise.

IFASP. In specifications that control for the interaction of the IFASP and deworming, β_3 is the effect of the IFASP only for schools that didn't receive deworming medication.

Next, I estimate heterogeneous effects by comparing the difference in β_3 when Equation 1 is estimated separately for students at different points in the distribution of hemoglobin levels at baseline. The results of this estimation strengthen the validity of the parallel trends assumption of the DD model, since differential trends that could be biasing the results would have to differ by baseline hemoglobin level as well. Understanding the pattern of distribution of IFASP tablets to schools will further strengthen the validity of this assumption if distribution is not related to any observable characteristic that would suggest differential trends in child health.

The second heterogeneous effects estimation will allow the effect of the IFASP to vary by whether or not students attend schools that ran out of tablets, did not run out of tablets, or are uncertain. This estimation takes the form:

$$\mathbf{Hb}_{ist} = \alpha_0 + \alpha_1\mathbf{IFASP}_s + \alpha_2\mathbf{post}_t + \alpha_3\mathbf{RanOut}_s + \alpha_4\mathbf{Uncertain}_s + \alpha_5(\mathbf{IFASP}_s \times \mathbf{post}_t) + \alpha_6(\mathbf{IFASP}_s \times \mathbf{post}_t \times \mathbf{RanOut}_s) + \alpha_7(\mathbf{IFASP}_s \times \mathbf{post}_t \times \mathbf{Uncertain}_s) + \varepsilon_{ist} \qquad (2)$$

where RanOut is a dummy variable that is equal to one if the school reported running out of tablets and a zero otherwise and Uncertain is a dummy variable that is equal to one if the school reported not knowing if they had run out of tablets. The omitted category is schools that still have tablets to distribute at the time of the school survey and the remaining variables are defined as described above. Therefore, α_5 is the effect of the IFASP for students in schools that have not run out of tablets, α_6 is the additional effect of the IFASP in schools that ran out of tablets, and α_7 is the additional effect of the IFASP in schools that are uncertain whether or not they have run out of tablets. Recall that schools reported whether they had run out of tablets or still had tablets approximately two to four months before hemoglobin was measured. Thus, we should expect α_5 to be larger than the overall effect of the IFASP identified by β_3 in specification (1) and α_6 to be negative but smaller in magnitude than α_5. The expected sign of α_7 is ambiguous.

These specifications rely on a school-reported measure of IFASP receipt as an independent variable. While IFASP receipt is plausibly random, the school-reported measure of implementation likely contains substantial measurement error stemming from timing discrepancies surrounding IFASP tablet distribution, as discussed above. Whether or not a school has distributed all of their tablets does not account for differences in the frequency of distribution, and does not provide full information about how recently children received tablets. To address this measurement error, I test the effects of the IFASP for children who (a) likely received tablets more recently and (b) likely received tablets more frequently.

Recall that at time of the school survey (two to four months prior to hemoglobin measurement), three children were randomly sampled per school and asked if they received tablets daily and/or the day previous to the survey. The percent of these three children who answer yes to each question proxies for the recentness and frequency of tablet distribution at the school level. However, these measures are likely endogenous to student attendance, a potential omitted variable, and so I use an instrumental variables (IV) approach to isolate the exogenous variation in each measure. The IV results provide an estimate of the effect of the IFASP, driven by more immediate iron supplementation, since this specification evaluates changes in hemoglobin levels for children who received tablets more recently or frequently. In addition, the IV approach minimizes bias from measurement error since it relies on joint accounts of IFASP receipt. The instrument is whether or not schools report receiving IFASP tablets from the government. I estimate a two-stage least squares specification of the DD specification above, in which the independent variable is either the percent of the three children who report daily supplementation or the percent of the three children who report supplementation the previous day, instrumented by whether or not a school reported receiving IFASP tablets. I expect that the effect of more recent supplementation will be larger than the effect of more frequent distribution, but that both will likely be larger than the overall effect of the IFASP in the DD specification.

The first assumption of this IV model is that IFASP receipt from the government is correlated with children's reports. Table 2 confirms that this is the case. Otherwise, this specification rests on the same assumptions as the DD model above: receipt of IFASP tablets from the government is not correlated with trends in students' hemoglobin levels other than through children's receipt of the tablets. In fact, the DD specification is the reduced form of the IV specification.

The IV specification is also adjusted to control for whether or not a school received deworming medication, as above. However, I do not include an interaction between receiving IFASP tablets and deworming medication in the IV specification because it has little effect in the reduced form equations described above and is too highly collinear with receipt of IFASP tablets.

B. Implementation of the IFASP

Understanding the implementation patterns of the IFASP in its first year is key to helping ensure that future waves of the IFASP provide iron and folic acid tablets to every child in every school. It is also critical to the identifying assumptions necessary to estimate the causal effect of the IFASP on the children that received tablets in the first year of the program. There are many potential avenues for leakage within this system: in order for the program to have any chance of improving the iron status of children, the iron and folic acid supplements need to be transported from the state headquarters to each individual child. Recall the complicated distribution process of tablets from the central government to students described in detail above in Section 1B. Given that only 70 percent of schools in my sample received tablets from their BEO, there are clearly leakages at least within the first three stages of the chain of distribution (from the state to district, district to block, and block to schools).

Understanding the extent to which IFASP implementation was exogenous to trends in children's health indicators is necessary in order to evaluate the identifying assumption of the empirical strategy described above. The main concern is that implementation is correlated either directly with anemia prevalence or with some other predictor that also affects hemoglobin levels. Recall that there is substantial variation in implementation at the block level. I show that, while this variation across blocks matches patterns of school resource allocation implied by high levels of corruption and inefficiency, the pattern of distribution within blocks with high variation of IFASP implementation appears to be quasi-random.

Table 3 shows that the two blocks with over 95 percent IFASP implementation are different from the three blocks with substantial variation in IFASP implementation on a range of measures. Two-thirds of the observable school-level characteristics are statistically significantly different between the two types of blocks.[8] High implementation blocks are more advantaged across a range of demographic variables,

[8] Table 3 tests 37 observable demographics; 19 are significantly different at the 5 percent level and 4 more at the 10 percent level.

have parents that are more involved in implementation of the school lunch program, and are more likely to receive rice for that meal on a regular schedule from the BEOs. These blocks also have slightly higher anemia rates among children. These differences suggest that, at some point in the tablet distribution schedule between the SDMU and the BEO, the less remote/more advantaged blocks systematically received more tablets. This is consistent with other allocation systems influenced by incompetency and corruption. This also complicates the potential effectiveness of the IFASP: the children in blocks with close to universal tablet distribution are more anemic (increasing potential effectiveness) but also more advantaged: in general, anemia levels are positively correlated with poverty rates, so this would decrease potential effectiveness in other cases.

However, the main concern for the strategy described above is whether or not schools within the high-variation blocks received IFASP tablets systematically or quasi-randomly. Within these three blocks, there are two possible explanations for why some schools report receiving tablets and others do not that could be particularly worrisome. First, this variation could be non-randomly influenced by the BEOs, if any unobservable characteristics are correlated with whether the BEO gave the school the right number of tablets. For example, BEOs could choose to focus on certain types of schools. Second, this variation could be non-randomly influenced by the schools, if unobservable characteristics are correlated with (a) how schools implement the IFASP program or (b) how schools respond to the IFASP survey. My preferred measure of IFASP implementation (whether or not the school received the tablets from the BEO) helps minimize omitted variable bias from (a) since receipt of tablets does not rely on a school's ability to implement a program, but school characteristics may still be correlated with how schools respond to the question about IFASP receipt on the IFASP survey. However, further analysis supports none of these sources of bias (BEO- or school-induced). Finally, these systematic distribution patterns would only introduce bias if they were correlated with hemoglobin level trends in children. In addition to showing that there is little evidence to support these systematic distribution patterns, I also show that IFASP receipt is not predicted by students' anemia status or hemoglobin levels and that observable characteristics of schools are not correlated with the percent of students that are anemic in each school.

There are several ways in which the BEO could decide to distribute tablets non-randomly. The BEO could choose to first visit schools closer to the block headquarters, or schools that are closer to each other. More rural schools would then be systematically less likely to receive tablets. The BEO could also target schools that he thinks need the tablets most or schools that have more advantaged children, both of which would be based on his evaluation of the demographics of each village. Finally, the BEO could also choose to distribute tablets to schools with which he has a better relationship, or which he thinks will be most effective in implementing the program. Since the BEO also distributes the supplies for the national Mid-Day Meal (MDM) program (a subsidized school lunch program), he could choose to distribute the tablets first to schools that he views as 'good implementers' (based on their implementation of the MDM program), which he therefore thinks will use the tablets most effectively. On the other hand, it is also possible that the BEO distributes tablets to more schools than report receipt of tablets. In this case, the schools' non-random reporting of whether or not they receive IFASP tablets would be the main concern. This could lead to bias if being a 'good implementer' is correlated with the probability of reporting getting IFASP tablets.

To test these hypotheses for non-random tablet distribution (either BEO-induced or school-induced) I look first at summary differences between schools that received tablets and schools that did not, and then examine the ability of these measures to predict IFASP receipt in a multiple regression framework. To test the hypotheses for BEO-induced non-random distribution, I utilize the school's distance to the block headquarters and a range of demographic measures about each school. These measures include school-reported proxies for socioeconomic status, e.g. whether or not they have a kitchen or sufficient water, and a range of student household-reported proxies for socioeconomic status aggregated to the school level, e.g. the percent of families in agricultural work, the percent of families who own a phone, or the percent of families living in high- or low-quality housing. Finally, given data constraints it is impossible to fully untangle whether a BEO targeted schools with a high ability to implement a government program or whether headmasters that are better implementers were better at reporting tablet receipt – I simply observe the ability of a school to implement a government program through their success at implementing the MDM. Similarly to the IFASP, supplies for the MDM are distributed by the BEO to each school. For each school, I observe the (parent-reported) mean number of lunches provided per week and the percent of parents who are satisfied with the implementation of the MDM. Further, I observe (school-reported) whether or not a school uses a parent help group to provide the MDM, whether or not anyone from the school attended government MDM training, and whether or not a school gets regular scheduled visits from the BEO to deliver the rice for the MDM. This final measure is the only one that contains information about BEO decision-making; the rest simply measure the school's effectiveness at implementing the MDM.

As seen in Table 4, there is no significant difference in mean distance to the block headquarters among schools that got IFASP tablets and those that did not within the three blocks with high variation in IFASP implementation. Furthermore, over the range of observed demographics IFASP implementation, there are few observable differences between schools that received IFASP tablets and schools that did not. I have tested many observable demographic variables that the BEOs would be aware of. There are only three significant differences between these two types of schools: the percent of the population in a disadvantaged caste, the percent of villagers who report working in their own home not for pay, and the percent of villagers who report working in others' homes for pay.

In addition, there are no significant differences between schools that received tablets and those that did not that correspond to a school's ability to implement the MDM, as measured by the markers described above. I conclude that BEOs were not systematically targeting schools that they thought would most successfully implement the program, since schools that got tablets are not measurably better implementers. This additionally suggests that it is unlikely that schools received tablets but did not report them at the time of the school survey since those schools would be measurably worse implementers. This is bolstered by the fact that the majority of schools that did not receive tablets indicated that they were aware of the IFASP policy.

Furthermore, none of these variables overall are predictive of IFASP receipt in a regression of IFASP receipt on varying sets of demographic and school variables (Table 5). Columns (1) and (2) of Table 5 regress IFASP receipt on distance to the block headquarters and all observable demographic characteristics and MDM implementation variables (with and without block fixed effects). None of these observable characteristics significantly predict IFASP receipt either across or within blocks in the three blocks with high variation in IFASP implementation. However, this result may be caused by the smaller sample size due to missing data (n=124 schools). To account for this, the remaining columns consider subsets of the variables included in the first two columns. There are only two robustly significant predictors: the percent of villagers employed in housework outside the home and the percent of families in a non-disadvantaged caste. Given the number of variables tested, this is approximately the number we would expect to see significant by chance (at the 10% level). Overall, these regressions suggest that the BEO did not systematically target schools based on his observation of differences between schools or village populations.

If, however, the tablets were disproportionately given to more disadvantaged students within these three blocks (as suggested in Tables 4 and 5), the estimated effects of the IFASP could be biased in either direction, depending on how the trend in hemoglobin levels would have differed for advantaged and disadvantaged children in the absence of the IFASP. If advantaged children would have been on a faster trend (and were less likely to get tablets) than disadvantaged children, the results presented here are conservative estimates of the effect of the IFASP. More of a concern, if advantaged children would have been on a slower trend (because they are less anemic) then these results overestimate the effect of the IFASP. However, in this sample anemia and poverty are not strongly correlated, which suggests non-differential trends. Furthermore, controlling for whether a student is advantaged or disadvantaged does slightly increase the point estimate of the effect of the IFASP, suggesting that the first scenario is more likely.

My preferred differences-in-differences specification is reported in Table 6 with and without a set of control variables that proxy for the different decision-making processes that could influence BEOs. These control variables include: distance to the block headquarters, percent of parents satisfied with the school lunch program (i.e. implementing ability), percent of families in a non-disadvantaged caste and percent of families engaged in housework (village demographic indicators of socio-economic status), and whether or not a school has a kitchen (a school demographic indicator of socio-economic status). The inclusion of these control variables does not substantially alter the magnitude of the results of the main specifications described above, further supporting the conclusion that the BEO distributed tablets quasi-randomly.

Finally, there is no evidence that schools receiving tablets had students that were disproportionately more or less anemic. Overall within the three blocks with high variation in implementation rates, as well as within each block, there is no statistical difference in the prevalence of anemia, mild anemia, or moderate anemia between schools that received the IFASP tablets from the government and schools that did not (Table 4, Panel C). Additionally, there is no difference in the mean hemoglobin level or in standard nutritional markers like weight and height (either overall or differentiated by anemia status). Figure 2 plots the kernel densities of students' hemoglobin levels in schools that did and did not get IFASP tablets and shows that the distribution of hemoglobin levels at baseline among study children is quite similar in both types of schools, for both anemic and non-anemic children.[9]

Additionally, there are several explanations founded in the data that support the idea that the BEO in each of the blocks without enough tablets for everyone distributed his tablets quasi-randomly. Note that tablets were more likely to go to schools with a higher population of students in a disadvantaged caste (Tables 4 and 5), which would imply the BEO may have been attempting to target needier students. However, anemia rates in each village are not correlated with any observable demographic characteristic (Figure 3): a BEO could not target students who needed the iron supplements more, even if he wanted to. This is consistent with the literature that shows that in contexts with such widespread anemia and poverty, it is difficult to identify those most in need of iron supplementation without actually measuring iron deficiency (WHO 2015). Further, in this sample, only 11% of parents know what the health condition called 'anemia' is (*after* implementation of the IFASP). This suggests that even fewer adults are aware of the use of iron supplements to treat the micronutrient deficiency, and thus that there is no market for iron supplements, even if a BEO wanted to sell them. Overall, this suggests that the BEO would distribute all of the provided tablets to schools and that he would do so in a way unrelated to underlying trends in children's hemoglobin levels.

Finally, schools that report having already run out of tablets at the time of the school survey appear very similar to schools that do not run out on the same range of characteristics described above, suggesting that both the timing of tablet distribution and the number of tablets provided per student are also likely not systematically

[9] A similar analysis at the child-level with students who have anthropometric data at both baseline and midline (the final sample of children used in the analysis) confirms that there are no demographic or nutritional differences in sample children at baseline between students who would eventually receive IFASP tablets and those who would not (Appendix Table A2).

determined by the BEO and rather, were largely determined by chance.[10] Together, these facts together with the descriptive analysis above support the quasi-random distribution of tablets within each block.

Conditional on school receipt of IFASP tablets, there is reason to believe that the IFASP has the potential to have a positive effect of student hemoglobin levels: surveys of randomly selected students confirm that students were receiving tablets in schools and swallowing the tablets upon receipt. In the summer of 2014 (after the second year of the IFASP had commenced), 76 percent of students surveyed reported receiving tablets in schools. Conditional on tablet receipt from the school, the student-reported compliance rate was over 99%. While this high compliance rate (relative to compliance rates reported in programmatic evaluations) may have been influenced by interviewer scrutiny, it may also stem from student experience participating in the MDM and the fact that students often took their supplements with the school meal, minimizing side effects. Based on these data that suggest that individual students received the tablets and then swallowed them, I anticipate a positive effect of the IFASP on hemoglobin levels.

Section V: Results

Table 6 presents results from specification (1), the DD analysis estimating the effectiveness of the IFASP in raising student hemoglobin levels. The dependent variable is a child's hemoglobin level and the key independent variable is an indicator for whether or not the school reported receiving IFASP tablets from the government.[11] For this and all subsequent tables, the even-numbered columns include school fixed-effects and the additional control variables interacted with the "post" indicator, as described in Section 4B. Adding the controls changes the magnitude of the estimated effect of the IFASP slightly and increases the significance of the results. Columns 3-6 additionally control for the receipt of deworming medication from the government, which does

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[10] Two key differences are that schools that ran out of tablets for primary school children have much larger average secondary school enrollment (and perhaps they redistributed tablets designated for primary students to secondary students) and are also much less likely to receive their rice for the school lunch program on a regular schedule (indicating less frequent contact with the BEO). See Appendix Table A3 for the full range of statistics.

[11] Results are qualitatively similar when the independent variable is (a noisy) measure of the number of tablets received per student.

affect the magnitude of the estimated effect of the IFASP. Controlling for receipt of deworming medication, the effect of the IFASP is marginally significant with the inclusion of fixed effects and control variables: attending a school that reported receiving IFASP tablets increases children's hemoglobin levels by 0.280-0.307 g/dL. This effect is of the expected magnitude for combined anemic and non-anemic students in a real-world iron supplementation program.[12] Unexpectedly, there is a negative and significant effect of attending a school that received deworming medication. The effect is no longer significant when estimated separately for schools that did or did not get IFASP tablets. The robustness of this effect is brought into question in later heterogeneous effects specifications separated by anemia status, where the effect of deworming fluctuates in sign.[13] Finally, the simultaneous receipt of both deworming medication and IFASP tablets may reduce the effect of the iron supplementation tablets, but the relevant coefficient is not statistically significantly different from zero.[14]

To support the parallel trends assumption that students who received IFASP tablets were not trending differently in hemoglobin levels from those who did not receive tablets, I next show heterogeneous effects of the IFASP that are consistent with a causal interpretation of the DD specification (Table 7). If the DD results were driven by differential trends instead of the IFASP, we would have no reason to expect the results to be bigger for anemic students than non-anemic students. I divide the sample by baseline anemia status: non-anemic students (hemoglobin concentration over 12.5 g/dL at baseline), borderline anemic students (hemoglobin concentration between 11.5 and 12.5 g/dL at baseline), mildly anemic students (hemoglobin concentration between 11 and 11.5 g/dL at baseline), and moderately anemic students (hemoglobin concentration

[12] In the study most similar to this one in both supplementation program and empirical design, Luo et al. (2012) find the overall effect of school-based iron supplementation to be 0.23 g/dL for 4th graders in rural China.

[13] The negative effects of attending a school that received deworming medication could be a consequence of selection rather than a causal estimate. However, as seen in Appendix Table A4, any differences in schools that got deworming medication indicate that those schools may have been more advantaged and potentially better program implementers. This contradicts the negative estimated effect of deworming in these data. Further investigation of this effect is left to future work.

[14] Appendix Table A5 presents results for this DD analysis with height and weight as the outcome variables. Existing literature shows no effect of iron supplementation on height and mixed, inconclusive effects on weight (Low et al. 2013; Vucic et al. 2013). Table A4 shows that the IFASP had no effect on height and a very small but highly significant effect on weight. In this context, iron supplementation could increase weight by reducing lethargy and increasing school attendance, thereby increasing weight if students receive more nutritional school lunches. Further research into this effect and its mechanisms is left to future work.

between 8 and 11 g/dL at baseline).[15] Note that "mild" anemia is a misnomer in that the negative effects of iron deficiency are already substantial by the time any level of anemia is diagnosed (WHO 2011). Similarly, borderline-anemic students are likely to be suffering from many of the negative effects of iron deficiency as well. The majority of the children in this sample are mildly or moderately anemic. As shown in existing literature, I expect the effect of the IFASP to be largest for the most anemic students and smallest for the non-anemic students. Table 7 presents the results from this heterogeneous effects model and illustrates that this expectation largely holds, providing additional support for the parallel trends assumption of the simple DD specification.

Focusing on the estimations that include school fixed effects, the IFASP has an insignificant effect on the students with the highest baseline hemoglobin levels that fluctuates in sign between models. These students additionally experience a negative insignificant effect of the interaction of deworming medication and iron supplementation. The effect is larger and positive across all specifications for non-anemic borderline-anemic students (0.09-0.37 g/dL with controls), but still insignificant. Borderline anemic students also have a negative point estimate on the interaction effect of the IFASP and deworming receipt. The largest and only statistically significant effect of the IFASP occurs for mildly anemic students: the IFASP causes a significant increase in hemoglobin levels of 0.49-0.84 g/dL with the inclusion of school fixed-effects and control variables including deworming receipt. This effect is about twice as large as the overall effect for all students reported in Table 6, and is large enough to shift these children from being classified as mildly anemic to only borderline anemic.

Finally, the effect of the IFASP for moderately anemic students ranges from 0.218-0.248 g/dL with the inclusion of controls for deworming receipt and is insignificant. While the finding that the effect on moderately anemic students is smaller than the effect on mildly anemic students seems surprising, there are two possible related reasons for this finding. First, the most anemic students may not have received enough iron through the IFASP to build up sufficient iron stores, for example, because of more infrequent school attendance due to the negative effects of anemia like

[15] These hemoglobin cutoffs are as defined by WHO standards at sea level and apply to the majority of the sample (5-11yo). Several students outside this age range are classified by alternate age-appropriate cutoffs (see Appendix Table A6).

increased lethargy.[16] Second, note that moderately anemic students are the only subgroup to have a positive (insignificant) point estimate of the interaction effect of iron supplementation and deworming. This indicates that the most anemic students may have also been those with the highest worm loads. Both of these hypotheses imply that these children would therefore have experienced smaller immediate effects of iron supplementation as well as the most dramatic falls in hemoglobin levels when they ceased receiving iron supplements. On the other hand, students who were mildly anemic at baseline are likely less susceptible to these timing discrepancies if they were more able to build up sufficient iron stores over the course of their supplementation. Since hemoglobin measurement was done over the summer vacation, the measureable effect for mildly anemic students persisted while the effect for moderately anemic students did not.

These results imply that school-based iron supplementation programs may not be sufficient to reduce the most severe cases of anemia (affecting one-third of children in this sample), but may be most effective in improving the hemoglobin levels of borderline or mildly anemic students and therefore preventing them from developing more severe levels of anemia. A main disadvantage of using the school system to distribute tablets is that the program only reaches kids who attend school frequently. These results are likely to generalize to other school-based nutrition programs, which would face many of the same constraints.

Next, I examine the heterogeneous effects for students whose schools report running out of tablets ahead of the school survey (and therefore far ahead of the measurement of children's hemoglobin levels). Table 8 presents the results from specification (2) above, which support the hypothesis that students with more recent iron supplementation are driving the measurable effect of the IFASP described above. In schools that still had tablets to distribute at the time of the school survey (the omitted category), the IFASP increased children's hemoglobin levels by a marginally significant 0.414 g/dL. Students in schools that reported uncertainty regarding whether or not they had run out of tablets experienced an IFASP effect of similar magnitude. However, the effect for students in schools that ran out of tablets at least two to four months before hemoglobin measurement was significantly reduced by 0.311 g/dL. Thus, they still

[16] This hypothesis is testable with attendance data forthcoming from the field.

experienced a positive effect of the IFASP but the effect was diminished by the time of hemoglobin measurement (and is not statistically significant).

These findings suggest that the relatively small effects of the IFASP found here may be rooted in the delay between supplementation in schools and the measurement of children's hemoglobin levels, therefore understating the actual effectiveness of the program. This is not unexpected, given the life cycle of a red blood cell and the low levels of iron naturally present in most Indian diets. These results also indicate that the policy was successful in getting tablets to children, but was limited by the undersupply of tablets in particular administrative blocks and certain schools. Furthermore, these findings suggest that school-based programs like the IFASP, while successful, may not be wholly effective in persistently reducing the prevalence of anemia and iron deficiency if children are not consistently receiving iron tablets, for example during summer vacations.

The IV specification aims to further understand the effects of recent and/or frequent tablet distribution. The results confirm much larger effects of more recent supplementation compared to both the effect of more frequent supplementation and the overall effect of a school implementing the policy. Recall that at the time of the school IFASP survey, three children per school were randomly sampled and interviewed at school about their experience with IFASP implementation. The independent variables of interest in the IV specification are the percent of those three children per school who responded that they receive IFASP tablets daily (a proxy for frequency) or the percent of those three children per school who responded that they received IFASP tablets the day before the survey (a proxy for recentness).[17] Because of possible endogeneity in these measures, they are instrumented with the school-reported measure of IFASP receipt used in the original DD specification. The outcome variable is still students' hemoglobin levels. Table 9 presents these results for the overall sample, and Tables 10A and 10B present the heterogeneous effects specifications, similar to above.

[17] This school survey occurred 2-4 months before students' hemoglobin levels were measured at midline. Therefore it only indicates more recent supplementation rather than ongoing supplementation at time of hemoglobin measurement.

Focusing on the results in Table 9, Column 4, which include controls for deworming[18] and school fixed effects, the point estimate of the effect of daily distribution is to raise students' hemoglobin levels by 0.396 g/dL (insignificant) and the effect of more recent distribution is to raise students' hemoglobin levels by a marginally significant 1.176 g/dL. This magnitude is similar to the effects of iron supplementation in efficacy trials that measure the effects of ongoing increased iron intake. Further, these findings support the hypothesis that the effect of the IFASP is driven by children who have gotten iron supplements more recently, as expected.

Table 10A presents the heterogeneous effects model for the IV specification estimating the effect of daily supplementation. These results mirror those from the heterogeneous effects DD specification: the effects increase as initial hemoglobin levels fall, with the largest effect for mildly anemic students. The effect of daily distribution of tablets is to raise mildly anemic students' hemoglobin levels significantly by 0.725 g/dL. Table 10B presents the analogous specification estimating the effect of more recent supplementation. The pattern of the magnitudes of effects for each subgroup mirrors the pattern in all previous heterogeneous effects results. These effects are larger, across the board, than either the effect of IFASP receipt or the effect of daily supplementation, suggesting that the recentness of supplementation is the most important factor leading to increases in children's hemoglobin levels. Mildly anemic students experienced marginally significant increases in hemoglobin levels of 1.6-2.9 g/dL if they attended schools that provided supplements to students the day before the school survey. This is consistent with the idea that the effects of supplementation likely fade after two to four months without supplementation. Further, this suggests that policies that attempt to both prevent and treat iron-deficiency anemia may need to be implemented more consistently in order to see persistent effects.

Because the measure of recentness of supplementation in Table 10B indicates supplementation that occurred two to four months before hemoglobin level measurement, these results do not refute the hypothesis that the moderately anemic students relapsed the most quickly post-supplementation, even though the effects for

[18] The IV specification does not include the interaction of measures of IFASP implementation and deworming because the effect was not significant in the previous specifications and relatively high collinearity between IFASP and deworming receipt wouldn't allow for both to be used as instruments simultaneously.

moderately anemic students are smaller than those for mildly anemic students in the IV specification as well. Finally, consistent with Table 9, every group experiences effects of recent supplementation similar in magnitude to the effects of ongoing iron supplementation measured by efficacy trials for different subgroups.

Overall, the results reported here suggest that the IFASP had a moderate effect on children's hemoglobin levels in schools that reported receiving tablets from the government. Further, these findings support the hypothesis that the largest effects were measured for children who received tablets most recently and those who had lower hemoglobin levels at the onset of the program. Given that a large number of children had likely gone without iron supplements for several months at the time of hemoglobin measurement, the overall effects reported here are relatively large.

One persistent contradiction evident in the results presented here is the potential negative effect of deworming on hemoglobin levels and the insignificant interaction between deworming and iron supplementation. While data constraints limit the further evaluation of these effects in this study, the phenomenon should be further studied in real-world programs that implement both biannual deworming regimens and weekly or daily iron supplementation in schools.

Section VI: Discussion and Conclusions

These findings suggest that a school-based iron supplementation program has substantial potential to improve hemoglobin levels and reduce anemia prevalence for school-aged children in districts similar to Keonjhar District. First, implementation of the program, while not perfect, was not plagued by systematic distribution by corrupt officials within each block. Given student reports of tablet receipt and the fact that there was a positive effect on children's hemoglobin levels, we can infer that, once the tablets made it to schools, they were appropriately distributed to students. This implies that the main barrier to total coverage of the program was the misallocation of tablets to states or districts, and that the program could be effective in reaching its goals if enough tablets were provided to each block and to each school.

In the second year of the program, 100% of the schools in all five blocks of Keonjhar District reported receiving tablets from the government.[19] Of the schools that had received tablets in the first year, more than half of them received more tablets in the second year than they did in the year before. Finally, over 95 percent of schools in all five blocks received deworming medication in the second year. Overall, these data suggest that the administrative wrinkles were quickly and effectively ironed out of the IFASP, and that it therefore stands to have a substantial impact on the prevalence of iron deficiency and anemia in its second (and subsequent) year(s).

However, there are still limitations facing the IFASP and other school-based programs. The policy had larger measurable effects for students who received tablets closer to the time that their hemoglobin levels were measured. This suggests that in the intervening time between rounds of supplementation in school, children's hemoglobin levels may fall. This could occur whenever schools run out of tablets or more systematically when students are out of school for long periods of time (e.g. the summer holiday from May-June). There are two obvious solutions, although they may be difficult to implement: first, ensuring that schools receive enough tablets and second, providing students with tablets to take home over school vacations. While out-of-school tablet provision and student compliance may work differently than in-school provision and compliance, students would be less likely to experience falls in hemoglobin levels over the summer months.

In addition, the finding that IFASP gains were concentrated among students who received tablets most recently suggests that the true overall effects of the IFASP on hemoglobin levels were larger than those estimated in this analysis. Given that the overall effects measured here were on the lower bound of the expected effect of iron supplementation programs in general, the IFASP could potentially be very successful in reducing the prevalence of iron deficiency and anemia among school-age children in India. Furthermore, the largest effects of the IFASP were concentrated among anemic or borderline anemic (i.e. iron deficient) children, suggesting that it could be particularly effective in reducing iron deficiency among children who are not yet presenting visible signs of moderate or severe anemia.

[19] A second IFASP uptake survey was conducted in December 2014; almost all schools across all five administrative blocks had received and were distributing tablets by then.

On the other hand, the IFASP was less effective in improving the hemoglobin levels of moderately anemic students. It is possible that the IFASP is not intensive enough to fully treat students who already present such high degrees of iron deficiency, or that it does not reach those students as effectively because they are less likely to regularly attend school. Therefore, additional programs or treatments may be required to help the most anemic students. In the long term, however, the IFASP may reduce the number of students who become moderately or severely anemic since it is so effective in improving the hemoglobin levels of borderline or mildly anemic students.

One concern surrounding the efficacy of iron supplementation that was not tested here was whether or not the efficacy of supplementation was affected by students' other micronutrient deficiencies. For example, sufficient quantities of Vitamin C are necessary in order to absorb iron supplements. One possible explanation for the relatively small overall effects of the IFASP estimated in the DD specification could be that students do not get enough of these other micronutrients in their diets, and thus their bodies do not absorb all of the additional iron that they receive as supplements. This remains a potential limitation to the IFASP and should be tested in future research. A solution to this issue would be to provide additional micronutrient supplements in addition to iron.

Despite many challenges facing the successful implementation of the IFASP, it was relatively effective in improving hemoglobin levels for the school-age children attending schools that received iron and folic acid tablets in the first year of the program. Although there are changes that could make the IFASP more effective, these results are promising – in combination with the improved distribution of IFASP tablets in the second year of the program, they indicate that this school-based iron supplementation program may have substantial effects on the high rates of iron deficiency and anemia among school-age children in India.

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Tables

Table 1: School-level summary statistics by block (means reported)

		Blocks with high variation in IFASP			Blocks with low variation in IFASP	
	Panel A: Demographic Characteristics	**Block 1**	**Block 2**	**Block 3**	**Block 4**	**Block 5**
School-reported (SCH)	Distance to the block headquarters (km)	19.16	21.70	24.00	26.29	21.75
	Primary enrollment	91.42	69.28	68.29	67.99	51.24
	Secondary enrollment	39.33	25.77	30.29	26.90	22.83
	Number of teachers	2.72	2.48	2.33	2.64	2.13
	Percent of schools have a kitchen	0.53	0.87	0.55	0.83	0.78
	Percent of schools have at least one latrine	0.83	0.91	0.62	0.79	0.93
	Percent of schools have sufficient water	0.67	0.76	0.84	0.68	0.63
Household-reported, aggregated to school level (HH)	Mean % of students are female	0.47	0.51	0.52	0.50	0.51
	Mean % of families in a non-disadvantaged caste	0.03	0.04	0.06	0.10	0.11
	Mean % of village adults in agricultural work	0.13	0.22	0.17	0.19	0.20
	Mean % of village adults work in own home	0.24	0.25	0.30	0.23	0.23
	Mean % of village adults work in others' homes	0.30	0.25	0.25	0.16	0.21
	Mean % of village adults work as laborers	0.25	0.13	0.16	0.30	0.23
	Mean % of village adults with no formal schooling	0.79	0.50	0.48	0.48	0.45
	Mean % of village adults who own a phone	0.15	0.36	0.42	0.38	0.41
	Mean % of families that live in high-quality housing	0.05	0.12	0.08	0.11	0.14
	Mean % of families that live in low-quality housing	0.89	0.71	0.76	0.65	0.63
	Mean % of families with electricity	0.46	0.54	0.55	0.58	0.52
	Panel B: Implementer Variables					
SCH	Percent with parent group for MDM	0.06	0.09	0.35	0.72	0.53
	Percent with MDM training	0.47	0.66	0.45	0.15	0.15
	Percent receiving MDM rice on a regular schedule	0.73	0.26	0.20	0.40	0.52
HH	Mean number of MDM per week	4.53	4.81	5.01	4.40	4.91
	Mean % of parents satisfied with MDM	0.94	0.88	0.91	0.90	0.84
	Panel C: Anthropometric Measures at Baseline					
Child-level measures aggregated to school level and averaged	Mean % of students with anemia	0.60	0.58	0.46	0.65	0.60
	Mean % with mild anemia	0.23	0.23	0.22	0.23	0.25
	Mean % with moderate anemia	0.36	0.33	0.24	0.41	0.34
	Mean % with severe anemia	0.01	0.01	0.00	0.01	0.01
	Mean child Hb level	11.13	11.16	11.52	10.96	11.13
	Mean student BMI	14.01	13.60	13.35	13.59	13.51
	Mean BMI, anemic students	13.95	13.53	13.28	13.63	13.54
	Mean BMI, nonanemic students	14.19	13.69	13.38	13.57	13.51
	Mean student weight	18.38	18.28	18.22	18.13	18.10
	Mean weight, anemic students	17.76	17.58	17.83	17.84	17.62
	Mean weight, nonanemic students	19.79	19.33	18.67	18.69	18.83
	Mean BMI, girls	13.79	13.48	13.29	13.47	13.35
	Mean BMI, boys	14.25	13.69	13.45	13.68	13.67
	Panel D: IFASP Implementation Variables					
SCH	Percent of schools received IFASP	0.49	0.83	0.62	0.95	0.99
	Mean number of IFASP tablets received per student (conditional)	15.12	57.47	38.45	65.74	101.27
	Mean percent of 3 kids saying they receive tablets daily	0.19	0.52	0.56	0.80	0.69
	Mean percent of 3 kids saying they received tablets the previous day	0.12	0.23	0.10	0.27	0.39
	Percent received deworming medication	0.42	0.77	0.67	0.93	0.81
	Mean number of deworming doses per student (conditional)	1.76	2.59	2.10	2.32	2.37
	Number of schools	43	93	21	117	103

Table 2: Comparing school and child-reported measures of IFASP implementation

		IFASP		No IFASP	
		N	%	N	%
Schools in blocks with variation in IFASP implementation		**111**	**100%**	**46**	**100%**
March/April School Survey	At least 2 of 3 children asked said they received IFA tablets daily	*64*	*58%*	*0*	*0%*
	At least 2 of 3 children asked said they received IFA tablets the previous day	*27*	*24%*	*0*	*0%*

Table 3: Comparison of high-variation and low-variation blocks

		High IFASP variation	Low IFASP variation	P-Value
	Panel A: Demographic Characteristics	**Blocks 1-3**	**Blocks 4-5**	
School-reported (SCH)	Distance to the block headquarters (km)	21.31	24.17	**0.0218**
	Primary enrollment	75.21	60.15	**0.0004**
	Secondary enrollment	30.09	24.99	0.2082
	Number of teachers	2.53	2.40	0.4332
	Percent of schools have a kitchen	0.73	0.81	**0.0984**
	Percent of schools have at least one latrine	0.85	0.86	0.8817
	Percent of schools have sufficient water	0.74	0.66	**0.0770**
Household-reported, aggregated to school level (HH)	Mean % of students are female	0.50	0.51	0.5813
	Mean % of families in a non-disadvantaged caste	0.04	0.10	**0.0000**
	Mean % of village adults in agricultural work	0.19	0.20	0.5387
	Mean % of village adults work in own home	0.25	0.23	**0.0325**
	Mean % of village adults work in others' homes	0.26	0.18	**0.0000**
	Mean % of village adults work as laborers	0.16	0.27	**0.0000**
	Mean % of village adults with no formal schooling	0.57	0.46	**0.0000**
	Mean % of village adults who own a phone	0.31	0.39	**0.0000**
	Mean % of families that live in high-quality housing	0.09	0.13	**0.0096**
	Mean % of families that live in low-quality housing	0.77	0.64	**0.0000**
	Mean % of families with electricity	0.52	0.55	0.2621
	Panel B: Implementer Variables			
SCH	Percent with parent group for MDM	0.12	0.63	**0.0000**
	Percent with MDM training	0.58	0.15	**0.0000**
	Percent receiving MDM rice on a regular schedule	0.38	0.46	0.1458
HH	Mean number of MDM per week	4.76	4.64	**0.0839**
	Mean % of parents satisfied with MDM	0.90	0.87	**0.0025**
	Panel C: Anthropometric Measures at Baseline			
Child-level measures aggregated to school level and averaged	Mean % of students with anemia	0.57	0.63	**0.0002**
	Mean % with mild anemia	0.23	0.24	0.4324
	Mean % with moderate anemia	0.33	0.38	**0.0007**
	Mean % with severe anemia	0.01	0.01	0.5127
	Mean child Hb level	11.20	11.04	**0.0003**
	Mean student BMI	13.68	13.55	**0.0909**
	Mean BMI, anemic students	13.61	13.59	0.7295
	Mean BMI, nonanemic students	13.79	13.54	**0.0157**
	Mean student weight	18.30	18.11	0.2002
	Mean weight, anemic students	17.66	17.74	0.6851
	Mean weight, nonanemic students	19.36	18.75	**0.0117**
	Mean BMI, girls	13.54	13.41	0.1900
	Mean BMI, boys	13.81	13.67	**0.0447**
	Panel D: IFASP Implementation Variables			
SCH	Percent of schools received IFASP	0.71	0.97	**0.0000**
	Mean number of IFASP tablets received per student (conditional)	49.92	82.10	**0.0000**
	Mean percent of 3 kids saying they receive tablets daily	0.44	0.75	**0.0000**
	Mean percent of 3 kids saying they received tablets the previous day	0.18	0.33	**0.0007**
	Percent received deworming medication	0.66	0.88	**0.0000**
	Mean number of deworming doses per student (conditional)	2.42	2.34	0.7478
	Number of schools	157	220	

Note: P-value tests the difference in the two means, unconditional on block. Bolded p-values are significant at the 10% level.

Table 4: Comparison of IFASP, non-IFASP schools in high-variation blocks

		Blocks with high IFASP variation		
	Panel A: Demographic Characteristics	Got IFASP	No IFASP	P-Value
School-reported (SCH)	Distance to the block headquarters (km)	20.59	23.02	0.1355
	Primary enrollment	75.02	75.67	0.9330
	Secondary enrollment	29.73	30.96	0.8691
	Number of teachers	2.61	2.33	0.3328
	Percent of schools have a kitchen	0.77	0.64	0.1085
	Percent of schools have at least one latrine	0.86	0.83	0.5644
	Percent of schools have sufficient water	0.76	0.69	0.3584
Household-reported, aggregated to school level (HH)	Mean % of students are female	0.50	0.50	0.6869
	Mean % of families in a non-disadvantaged caste	0.03	0.06	**0.0320**
	Mean % of village adults in agricultural work	0.20	0.18	0.2398
	Mean % of village adults work in own home	0.27	0.22	**0.0112**
	Mean % of village adults work in others' homes	0.25	0.30	**0.0057**
	Mean % of village adults work as laborers	0.15	0.18	0.1367
	Mean % of village adults with no formal schooling	0.56	0.60	0.3012
	Mean % of village adults who own a phone	0.30	0.33	0.4004
	Mean % of families that live in high-quality housing	0.09	0.11	0.2287
	Mean % of families that live in low-quality housing	0.77	0.77	0.9963
	Mean % of families with electricity	0.52	0.51	0.7547
	Panel B: Implementer Variables			
SCH	Percent with parent group for MDM	0.10	0.16	0.3282
	Percent with MDM training	0.61	0.51	0.2771
	Percent receiving MDM rice on a regular schedule	0.36	0.43	0.3551
HH	Mean number of MDM per week	4.81	4.63	0.1019
	Mean % of parents satisfied with MDM	0.90	0.90	0.7568
	Panel C: Anthropometric Measures at Baseline			
Child-level measures aggregated to school level and averaged	Mean % of students with anemia	0.56	0.58	0.5765
	Mean % with mild anemia	0.23	0.23	0.8608
	Mean % with moderate anemia	0.32	0.35	0.3013
	Mean % with severe anemia	0.01	0.00	**0.0210**
	Mean child Hb level	11.21	11.19	0.7580
	Mean student BMI	13.65	13.74	0.6224
	Mean BMI, anemic students	13.61	13.61	0.9926
	Mean BMI, nonanemic students	13.74	13.90	0.4661
	Mean student weight	18.33	18.21	0.6273
	Mean weight, anemic students	17.77	17.41	0.2806
	Mean weight, nonanemic students	19.29	19.55	0.5467
	Mean BMI, girls	13.51	13.60	0.6679
	Mean BMI, boys	13.77	13.90	0.3175
	Number of schools	111	46	

Note: P-value tests the difference in the two means, unconditional on block. Bolded p-values are significant at the 10% level.

Table 5: Predictors of IFASP receipt in high-variation blocks

	Dependent Variable: Received IFASP Indicator											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	All observed characteristics		**Demographic characteristics**		**Demographic characteristics**		**Sig. Predictors from Cols 1-6**		**Cols 7-8 + Implementer Variables**		**Final control variables**	
Distance to the block hq (km)	-0.004	-0.002	-0.003	-0.003	-0.003	0.006	--	--	--	--	-0.000	-0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.011)	--	--	--	--	(0.004)	(0.004)
Mean % of pop in non-disadvantaged caste	-0.909*	-0.745	-1.074**	-0.907*	-1.352**	-1.086	-1.061**	-0.853*	-0.929*	-0.710	-0.887**	-0.778*
	(0.532)	(0.524)	(0.517)	(0.504)	(0.659)	(1.062)	(0.475)	(0.458)	(0.492)	(0.473)	(0.440)	(0.420)
Percent of students are female	-0.066	-0.149	-0.012	-0.094	-0.320	1.926	--	--	--	--	--	--
	(0.475)	(0.464)	(0.470)	(0.456)	(0.430)	(1.162)	--	--	--	--	--	--
Primary enrollment	-0.001	-0.001	-0.001	-0.001	-0.002	0.004	--	--	--	--	--	--
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	--	--	--	--	--	--
Secondary enrollment	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	--	--	--	--	--	--
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	--	--	--	--	--	--
Number of teachers	0.062	0.049	0.055	0.046	0.061	-0.027	--	--	--	--	--	--
	(0.048)	(0.048)	(0.047)	(0.047)	(0.060)	(0.085)	--	--	--	--	--	--
Percent has a kitchen	0.034	-0.033	0.052	-0.022	0.254*	-0.149	--	--	--	--	0.086	-0.074
	(0.109)	(0.109)	(0.107)	(0.106)	(0.137)	(0.177)	--	--	--	--	(0.093)	(0.096)
Percent has at least one latrine	0.163	0.083	0.167	0.096	0.345**	-0.105	0.138	0.058	0.142	0.049	--	--
	(0.127)	(0.127)	(0.125)	(0.124)	(0.154)	(0.218)	(0.115)	(0.113)	(0.116)	(0.114)	--	--
Percent has sufficient water	0.043	0.066	0.037	0.047	-0.060	0.164	--	--	--	--	--	--
	(0.103)	(0.100)	(0.100)	(0.097)	(0.099)	(0.188)	--	--	--	--	--	--
Mean % of village adults in agricultural work	-1.415	-0.949	-1.532*	-1.198	-1.312*	-0.852	-0.919	-1.064	-0.820	-0.899	--	--
	(0.888)	(0.877)	(0.863)	(0.840)	(0.719)	(3.020)	(0.703)	(0.678)	(0.720)	(0.689)	--	--
Mean % of village adults work in own home	-0.318	-0.070	-0.435	-0.032	0.542	1.470	--	--	--	--	--	--
	(0.727)	(0.726)	(0.710)	(0.711)	(0.625)	(2.662)	--	--	--	--	--	--
Mean % of village adults work in others' homes	-0.982	-0.689	-1.133*	-0.715	-0.418	0.008	-0.822**	-0.735**	-0.840**	-0.731**	-0.843**	-0.551*
	(0.646)	(0.638)	(0.627)	(0.624)	(0.552)	(2.272)	(0.361)	(0.347)	(0.364)	(0.350)	(0.337)	(0.329)
Mean % of village adults work as laborers	-1.385*	-0.738	-1.570**	-0.910	-1.540**	0.530	-1.050*	-0.755	-0.972	-0.572	--	--
	(0.785)	(0.795)	(0.760)	(0.765)	(0.679)	(2.568)	(0.582)	(0.569)	(0.606)	(0.593)	--	--
Percent of villagers with no formal schooling	-0.385	0.026	-0.381	0.037	-0.034	-1.286	-0.561	-0.096	-0.529	-0.145	--	--
	(0.468)	(0.498)	(0.450)	(0.477)	(0.421)	(1.003)	(0.412)	(0.437)	(0.433)	(0.445)	--	--
Percent of villagers who own a phone	-0.357	-0.430	-0.475	-0.504	0.222	-1.910**	-0.448	-0.463	-0.413	-0.420	--	--
	(0.366)	(0.359)	(0.357)	(0.347)	(0.319)	(0.812)	(0.340)	(0.326)	(0.342)	(0.328)	--	--
Percent of villagers who live in high-quality housing	-0.903	-0.534	-0.896	-0.532	-0.715	-1.695	--	--	--	--	--	--
	(0.623)	(0.620)	(0.614)	(0.606)	(0.612)	(1.315)	--	--	--	--	--	--
Percent of villagers who live in low-quality housing	-0.196	-0.169	-0.253	-0.173	0.503	-2.168**	0.196	0.181	0.204	0.202	--	--
	(0.430)	(0.424)	(0.425)	(0.415)	(0.389)	(1.055)	(0.303)	(0.298)	(0.304)	(0.298)	--	--
Percent of villagers with electricity	0.086	0.099	0.050	0.081	0.100	-0.160	--	--	--	--	--	--
	(0.159)	(0.155)	(0.156)	(0.151)	(0.168)	(0.279)	--	--	--	--	--	--
Mean number of MDM per week	0.040	0.030	--	--	--	--	--	--	0.052	0.032	--	--
	(0.067)	(0.066)	--	--	--	--	--	--	(0.063)	(0.061)	--	--
Mean % of parents satisfied with MDM	0.290	0.598	--	--	--	--	--	--	0.298	0.602	0.444	0.856*
	(0.508)	(0.507)	--	--	--	--	--	--	(0.476)	(0.461)	(0.456)	(0.441)
Percent with parent group for MDM	-0.170	-0.061	--	--	--	--	--	--	--	--	--	--
	(0.130)	(0.134)	--	--	--	--	--	--	--	--	--	--
Percent with MDM training	0.095	0.047	--	--	--	--	--	--	--	--	--	--
	(0.092)	(0.090)	--	--	--	--	--	--	--	--	--	--
Percent receiving MDM rice on a regular schedule	-0.056	0.037	--	--	--	--	--	--	--	--	--	--
	(0.094)	(0.099)										
Constant	1.518	0.467	2.173***	1.294	0.660	2.334	1.531***	1.025**	0.943	0.263	0.531	-0.047
	(1.002)	(1.042)	(0.817)	(0.839)	(0.740)	(2.567)	(0.469)	(0.485)	(0.722)	(0.713)	(0.460)	(0.455)
Blocks	No Block F.E.	Block F.E.	No Block F.E.	Block F.E.	Block 2	Blocks 1 and 3	No Block F.E.	Block F.E.	No Block F.E.	Block F.E.	No Block F.E.	Block F.E.
N	124	124	124	124	76	48	124	124	124	124	124	124
R-squared	0.212	0.273	0.183	0.252	0.392	0.397	0.145	0.231	0.155	0.246	0.096	0.213

Note: Standard errors in parentheses. The dependent variable is the indicator for receiving IFASP tablets in every column. Columns 1 and 2 include every observable characteristic of each school; the remaining columns restrict to particular subsets of observable characteristics. Columns 3 and 4 only include demographic characteristics (at both the school and household level, see Table 1,3, or 4 for a description of which are reported by the household and aggregated to the school level and which are reported by the school). Columns 5 and 6 repeat the analysis for demographic characteristics but separate schools by block (blocks 1 and 3 are combined due to the small number of schools in each block). Columns 7 and 8 restrict the independent variables to those that are significant in any of the previous columns. Columns 9 and 10 repeat columns 7 and 8 but add indicators of implementing ability of each school. Finally, Columns 11 and 12 include the final control variables used in the main analysis of the paper. These include a proxy for each of the three possible ways in which BEOs could have distributed tablets systematically (for full discussion of these decision-making processes see Section 4B) as well as the two robustly significant variables in the previous columns. Significance at the 0.10, 0.05, and 0.01 levels indicated by *, **, and ***, respectively.

Table 6: Overall effect of the IFASP

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: Children's hemoglobin levels					
IFASP*Post	-0.047	0.053	0.199	0.280^	0.283	0.307^
	(0.141)	(0.165)	(0.150)	(0.178)	(0.202)	(0.202)
Deworming*Post	--	--	-0.345**	-0.329**	-0.210	-0.286
	--	--	(0.140)	(0.152)	(0.254)	(0.315)
IFASP*Deworming*Post	--	--	--	--	-0.205	-0.066
	--	--	--	--	(0.304)	(0.354)
N	1459	1413	1459	1413	1459	1413
School fixed effects?	No	Yes	No	Yes	No	Yes
Added controls?	No	Yes	No	Yes	No	Yes

Note: The dependent variable is child's hemoglobin level measured in g/dL. IFASP is a dummy variable that is one if a school reported receiving IFA tablets and zero otherwise. All regressions include an indicator for whether hemoglobin measurement was taken after IFASP implementation and the other relevant main effects of each interaction term. "Added controls" include the following variables interacted with "post": distance to block headquarters, whether or not a school has a kitchen, the percent of parents satisfied with MDM implementation, the percent of families employed in housework outside the home, and the percent of families in a non-disadvantaged caste. Standard errors clustered by school are in parentheses. Significance at the 0.15, 0.10, 0.05, and 0.01 levels indicated by ^, *, **, and ***, respectively.

Table 7: Heterogeneous effects of the IFASP by anemia level at baseline

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: Children's hemoglobin levels					
Panel A: Non-Anemic and Non-Borderline Anemic Students (Hb>=12.5 g/dL at baseline)						
IFASP*Post	-0.387^	-0.101	-0.118	0.141	0.214	0.192
	(0.257)	(0.284)	(0.284)	(0.368)	(0.362)	(0.379)
Deworming*Post	--	--	-0.356	-0.318	0.106	-0.221
	--	--	(0.284)	(0.347)	(0.435)	(0.788)
IFASP*Deworming*Post	--	--	--	--	-0.743	-0.147
	--	--	--	--	(0.558)	(0.934)
N	196	186	196	186	196	186
Panel B: Non-Anemic Borderline-Anemic Students (11.5 <= Hb < 12.5 g/dL at baseline)						
IFASP*Post	0.034	0.114	0.090	0.187	0.353	0.375
	(0.176)	(0.182)	(0.188)	(0.210)	(0.305)	(0.303)
Deworming*Post	--	--	-0.087	-0.115	0.214	0.117
	--	--	(0.190)	(0.193)	(0.250)	(0.280)
IFASP*Deworming*Post	--	--	--	--	-0.518^	-0.389
	--	--	--	--	(0.358)	(0.379)
N	420	410	420	410	420	410
Panel C: Mildly Anemic Students (11 <= Hb < 11.5 g/dL at baseline)						
IFASP*Post	0.028	0.307*	0.243	0.499**	0.496*	0.842***
	(0.173)	(0.177)	(0.225)	(0.231)	(0.299)	(0.305)
Deworming*Post	--	--	-0.015	-0.432***	-0.011	0.225
	--	--	(0.032)	(0.142)	(0.064)	(0.300)
IFASP*Deworming*Post	--	--	--	--	-0.532	-0.753*
	--	--	--	--	(0.440)	(0.455)
N	280	272	280	272	280	272
Panel D: Moderately Anemic Students (8 <= Hb < 11 g/dL at baseline)						
IFASP*Post	-0.003	0.066	0.218	0.277	0.180	0.248
	(0.169)	(0.185)	(0.242)	(0.243)	(0.326)	(0.317)
Deworming*Post	--	--	-0.288	-0.290	-0.371	-0.357
	--	--	(0.238)	(0.234)	(0.315)	(0.337)
IFASP*Deworming*Post	--	--	--	--	0.114	0.093
	--	--	--	--	(0.436)	(0.452)
N	539	521	539	521	539	521
School fixed effects?	No	Yes	No	Yes	No	Yes
Added controls?	No	Yes	No	Yes	No	Yes

Note: Receiving IFASP is a dummy variable that is one if a school reported receiving IFA tablets and zero otherwise. The dependent variable is a child's hemoglobin levels, measured in g/dL. All regressions include an indicator for whether hemoglobin measurement was taken after IFASP implementation and the other relevant main effects of each interaction term. Anemia levels are defined by the WHO standards at sea level. "Added controls" include the following school-level variables interacted with 'post': distance to block headquarters, the percent of parents satisfied with MDM, whether a school has a kitchen, the percent of families employed in housework outside the home, and the percent of students in a non-disadvantaged caste. Standard errors clustered by school are in parentheses. Significance at the 0.15, 0.10, 0.05, and 0.01 levels indicated by ^, *, **, and ***, respectively.

Table 8: Heterogeneous effects of the IFASP by tablet run-out status

	(1)	(2)	(3)	(4)
	Dependent variable: Children's hemoglobin levels			
IFASP*Post	0.006	0.128	0.303	0.414^
	(0.206)	(0.226)	(0.234)	(0.254)
IFASP*Post*UncertainTabletStatus	0.130	0.045	0.091	0.008
	(0.196)	(0.201)	(0.198)	(0.205)
IFASP*Post*RanOutOfTablets	-0.288	-0.259	-0.334*	-0.311^
	(0.201)	(0.196)	(0.198)	(0.197)
Deworming*Post	--	--	-0.370**	-0.363**
	--	--	(0.154)	(0.159)
N	1459	1413	1459	1413
P-value (F-test of 3 coefficients):	0.059	0.210	0.020	0.058
P-value (IFASP*Post + IFASP*Post*RanOut =0)	0.091	0.470	0.861	0.595
School fixed effects?	No	Yes	No	Yes
Added controls?	No	Yes	No	Yes

Note: The dependent variable is child's hemoglobin level measured in g/dL. IFASP is a dummy variable that is one if a school reported receiving IFA tablets and zero otherwise. Uncertain Tablet Status is a dummy variable that is a one if the school reported not knowing if they had run out of tablets, and Ran Out of Tablets is a dummy variable that is a one if the school reported running out of tablets. All regressions include an indicator for whether hemoglobin measurement was taken after IFASP implementation and the other relevant main effects of each interaction term. "Added controls" include the following variables interacted with "post": distance to block headquarters, whether or not a school has a kitchen, the percent of parents satisfied with MDM implementation, the percent of families employed in housework outside the home, and the percent of families in a non-disadvantaged caste. Standard errors clustered by school are in parentheses. Significance at the 0.15, 0.10, 0.05, and 0.01 levels indicated by ^, *, **, and ***, respectively.

Table 9: Overall effect of recent or frequent supplementation (IV specification)

	(1)	(2)	(3)	(4)
	Dependent variable: Children's hemoglobin levels			
Panel A:				
Daily*Post	-0.094	0.038	0.307	0.396
	(0.241)	(0.267)	(0.253)	(0.283)
Deworming*Post	--	--	-0.353**	-0.320**
	--	--	(0.151)	(0.158)
N	1357	1321	1357	1321
Panel B:				
PreviousDay*Post	-0.201	0.232	0.854	1.176^
	(0.615)	(0.674)	(0.692)	(0.790)
Deworming*Post	--	--	-0.340**	-0.313*
	--	--	(0.155)	(0.162)
N	1459	1413	1459	1413
School fixed effects?	No	Yes	No	Yes
Added controls?	No	Yes	No	Yes

Note: These are the results of a two-stage least square model. The dependent variable is child's hemoglobin level measured in g/dL. In panel A, the independent variable is the percent of 3 children randomly sampled per school who reported receiving IFA tablets daily. In panel B, the independent variable is the percent of 3 children randomly sampled per school who reported receiving a tablet the day before the survey. In both panels, the child-reported measure is instrumented by school receipt of the IFASP. These children were interviewed at the time of the school IFA survey, 2 months prior to endline Hb measurement. All regressions include an indicator for whether hemoglobin measurement was taken after IFASP implementation and the other relevant main effects of each interaction term. "Added controls" include the following variables interacted with "post": distance to block headquarters, whether or not a school has a kitchen, the percent of parents satisfied with MDM implementation, the percent of families employed in housework outside the home, and the percent of families in a non-disadvantaged caste. Standard errors clustered by school are in parentheses. Significance at the 0.15, 0.10, 0.05, and 0.01 levels indicated by ^, *, **, and ***, respectively.

Table 10A: Effect of daily supplementation by anemia status at baseline (IV)

	(1)	(2)	(3)	(4)
	Dependent variable: Children's hemoglobin levels			
Panel A: Non-Anemic and Non-Borderline Anemic Students (Hb>=12.5 g/dL at baseline)				
Daily*Post	-0.490	-0.122	-0.012	0.249
	(0.422)	(0.447)	(0.434)	(0.489)
Deworming*Post	--	--	-0.392	-0.310
	--	--	(0.282)	(0.326)
N	186	178	186	178
Panel B: Non-Anemic Borderline-Anemic Students (11.5 <= Hb < 12.5 g/dL at baseline)				
Daily*Post	0.044	0.187	0.110	0.257
	(0.304)	(0.300)	(0.296)	(0.305)
Deworming*Post	--	--	-0.061	-0.069
	--	--	(0.188)	(0.186)
N	398	390	398	390
Panel C: Mildly Anemic Students (11 <= Hb < 11.5 g/dL at baseline)				
Daily*Post	0.004	0.540^	0.314	0.725*
	(0.280)	(0.368)	(0.328)	(0.407)
Deworming*Post	--	--	-0.311^	-0.163
	--	--	(0.213)	(0.209)
N	252	248	252	248
Panel D: Moderately Anemic Students (8 <= Hb < 11 g/dL at baseline)				
Daily*Post	-0.098	-0.075	0.420	0.437
	(0.271)	(0.293)	(0.396)	(0.424)
Deworming*Post	--	--	-0.413*	-0.431*
	--	--	(0.245)	(0.249)
N	499	483	499	483
School fixed effects?	No	Yes	No	Yes
Added controls?	No	Yes	No	Yes

Note: These are the results of a two-stage least square model. The independent variable is the percent of 3 children randomly sampled per school who reported receiving IFA tablets daily, instrumented by school receipt of the IFASP. The dependent variable is a child's hemoglobin levels, measured in g/dL. Anemia levels are defined by the WHO standards at sea level. All regressions include an indicator for whether hemoglobin measurement was taken after IFASP implementation and the other relevant main effects of each interaction term. "Added controls" include the following school-level variables interacted with 'post': distance to block headquarters, the percent of parents satisfied with MDM, whether a school has a kitchen, the percent of families employed in housework outside the home, and the percent of students in a non-disadvantaged caste. Standard errors clustered by school are in parentheses. Significance at the 0.15, 0.10, 0.05, and 0.01 levels indicated by ^, *, **, and ***, respectively.

Table 10B: Effect of more recent supplementation by anemia status at baseline (IV)

	(1)	(2)	(3)	(4)
	Dependent variable: Children's hemoglobin levels			
Panel A: Non-Anemic and Non-Borderline Anemic Students (Hb>=12.5 g/dL at baseline)				
PreviousDay*Post	-2.020	-0.576	-0.367	0.412
	(1.419)	(1.629)	(0.967)	(1.072)
Deworming*Post	--	--	-0.418*	-0.227
	--	--	(0.254)	(0.260)
N	196	186	196	186
Panel B: Non-Anemic Borderline-Anemic Students (11.5 <= Hb < 12.5 g/dL at baseline)				
PreviousDay*Post	0.196	0.653	0.482	1.000
	(1.019)	(1.074)	(1.042)	(1.188)
Deworming*Post	--	--	-0.077	-0.095
	--	--	(0.190)	(0.198)
N	420	410	420	410
Panel C: Mildly Anemic Students (11 <= Hb < 11.5 g/dL at baseline)				
PreviousDay*Post	0.128	1.640^	1.306	2.961^
	(0.797)	(1.040)	(1.261)	(1.942)
Deworming*Post	--	--	-0.373	-0.373
	--	--	(0.272)	(0.363)
N	280	272	280	272
Panel D: Moderately Anemic Students (8 <= Hb < 11 g/dL at baseline)				
PreviousDay*Post	-0.011	0.219	0.796	1.030
	(0.572)	(0.617)	(0.898)	(0.949)
Deworming*Post	--	--	-0.310	-0.332
	--	--	(0.261)	(0.270)
N	539	521	539	521
School fixed effects?	No	Yes	No	Yes
Added controls?	No	Yes	No	Yes

Note: These are the results of a two-stage least square model. The independent variable is the percent of 3 children randomly sampled per school who reported receiving a tablet the day before the survey, instrumented by school receipt of the IFASP. The dependent variable is a child's hemoglobin levels, measured in g/dL. Anemia levels are defined by the WHO standards at sea level. All regressions include an indicator for whether hemoglobin measurement was taken after IFASP implementation and the relevant main effects of each interaction term. "Added controls" include the following school-level variables interacted with 'post': distance to block headquarters, the percent of parents satisfied with MDM, whether a school has a kitchen, the percent of families employed in housework outside the home, and the percent of students in a non-disadvantaged caste. Standard errors clustered by school are in parentheses. Significance at the 0.15, 0.10, 0.05, and 0.01 levels indicated by ^, *, **, and ***, respectively.

Figures

Figure 1: Timeline of data collection and policy implementation

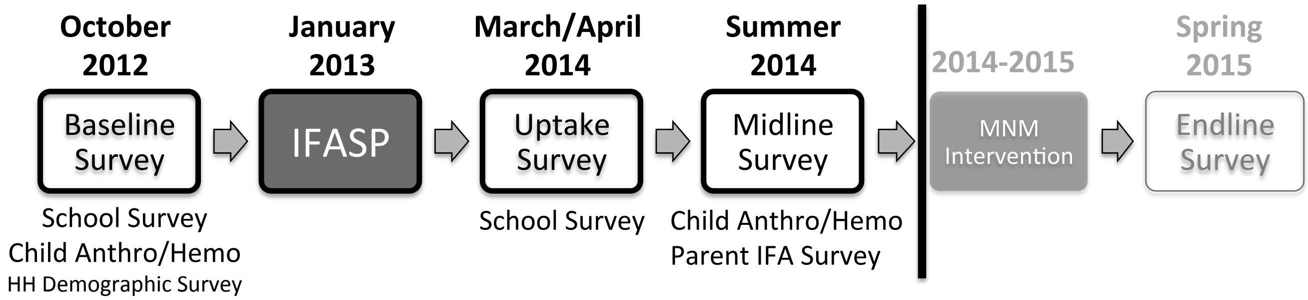
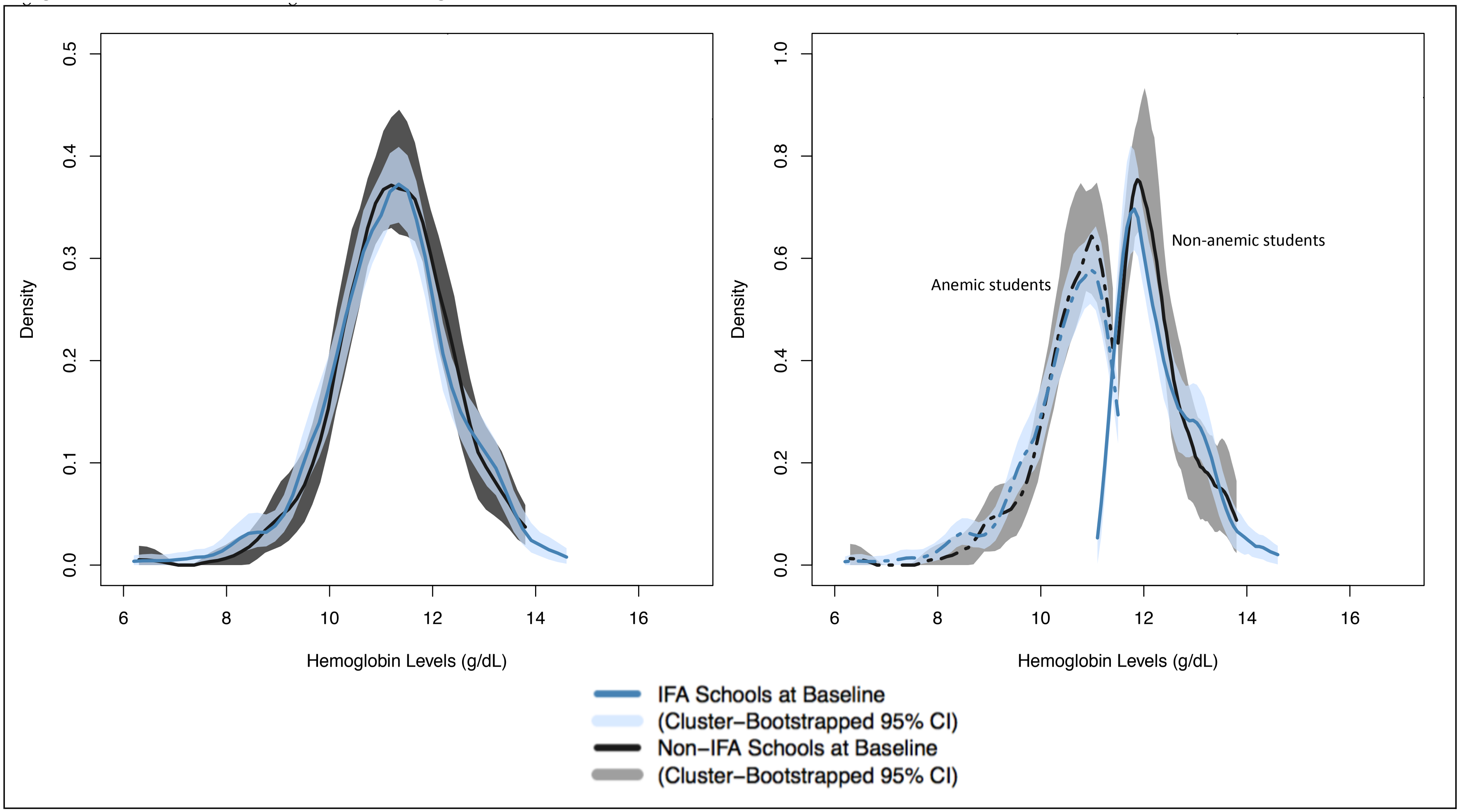
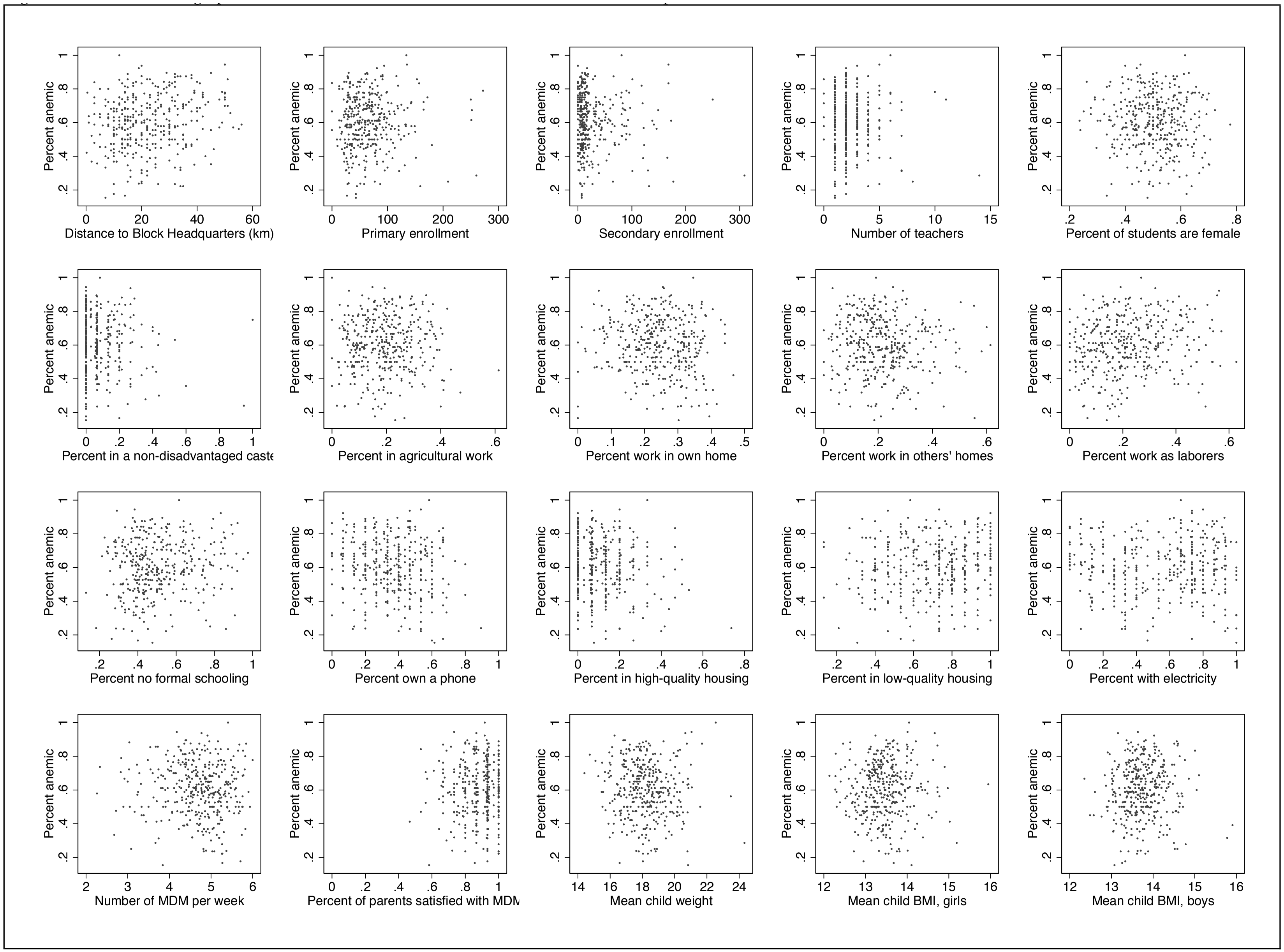


Figure 2: Distribution of child hemoglobin levels at baseline in IFASP and non-IFASP schools



Note: Kernel density plots of child hemoglobin levels at baseline with cluster-bootstrapped 95 percent confidence intervals. Each plot compares the distribution of hemoglobin levels in IFASP and non-IFASP schools.

Figure 3: Observable demographic characteristics at the school level are uncorrelated with anemia prevalence



Note: Each graph plots the percent of students per school who are anemic versus some observable demographic characteristic at the school level. Anemia prevalence is not correlated with any observable school characteristics.

Appendix

Table A1: Daily and previous day supplementation proxy for recentness and frequency

	Schools in all 5 Blocks				Schools in High-Variation Blocks			
School reports daily distribution	34.164**				56.807***			
	(14.673)				(20.035)			
3 students report daily distribution		9.553				10.530		
		(8.565)				(15.859)		
3 students report distribution yesterda			-24.937***				-32.472*	
			(9.066)				(18.780)	
School reports distributing all tablets				30.987***				36.118
				(11.274)				(22.680)
Constant	23.348*	45.610***	58.241***	34.223***	4.038	40.896***	52.909***	18.893
	(13.901)	(6.867)	(4.624)	(7.950)	(18.032)	(11.787)	(8.361)	(17.705)
N	273	308	319	177	100	105	111	64
R-squared	0.020	0.004	0.023	0.041	0.076	0.004	0.027	0.039

Note: Each column reports results from regressing the predicted number of days without tablets on measures used to proxy for recentness and frequency of tablet distribution. The predicted number of days without tablets was calculated by regressing the actual days without tablets (calculated from the date a school reported running out of tablets, n=46) on date of tablet receipt from the government, the number of tablets per student received, and a set of summary statistics variables. Standard errors are in parentheses. Significance at the 0.10, 0.05, and 0.01 levels indicated by *, **, and ***, respectively.

Table A2: Comparison of children in 'treatment' and 'control' groups

	Attends IFASP School	Attends Non-IFASP School	P-value
Percent mildly anemic	0.19	0.20	0.76
Percent moderately anemic	0.37	0.36	0.76
Percent severely anemic	0.01	0.00	0.42
Percent anemic	0.58	0.57	0.83
Mean BMI (kg/m^2)	13.32	13.46	0.17
Mean height (cm)	115.16	115.33	0.90
Mean weight (kg)	18.24	18.24	0.99
Mean MUAC (cm)	15.37	15.42	0.64
Percent literate	0.69	0.60	0.03
Percent male	0.49	0.46	0.56
Mean age	7.37	7.50	0.69
Mean educ. attainment of mother	2.61	3.12	0.11
Percent parents report enrolled	0.99	0.98	0.90

Note: P-value tests whether the two means are the same, unconditional on school or block.

Table A3: Comparison of schools that ran out of tablets to those that did not

		Blocks with high IFASP variation			
	Panel A: Demographic Characteristics	Didn't Run Out	Ran Out	Uncertain	P-Value
School-reported (SCH)	Distance to the block headquarters (km)	18.21	18.56	23.49	**0.0132**
	Primary enrollment	77.48	88.92	62.17	**0.0115**
	Secondary enrollment	23.48	50.97	15.43	**0.0005**
	Number of teachers	2.56	3.15	2.19	**0.0270**
	Percent of schools have a kitchen	0.76	0.82	0.74	0.7063
	Percent of schools have at least one latrine	0.92	0.84	0.85	0.6325
	Percent of schools have sufficient water	0.83	0.79	0.70	0.4480
Household-reported, aggregated to school level (HH)	Mean % of students are female	0.51	0.52	0.49	0.2814
	Mean % of families in a non-disadvantaged caste	0.03	0.05	0.02	0.2927
	Mean % of village adults in agricultural work	0.15	0.19	0.23	**0.0020**
	Mean % of village adults work in own home	0.26	0.27	0.26	0.8171
	Mean % of village adults work in others' homes	0.25	0.24	0.25	0.9121
	Mean % of village adults work as laborers	0.19	0.16	0.13	0.1014
	Mean % of village adults with no formal schooling	0.64	0.55	0.54	**0.0442**
	Mean % of village adults who own a phone	0.28	0.30	0.32	0.6020
	Mean % of families that live in high-quality housing	0.09	0.08	0.09	0.9090
	Mean % of families that live in low-quality housing	0.80	0.79	0.73	0.1441
	Mean % of families with electricity	0.50	0.54	0.52	0.8735
	Panel B: Implementer Variables				
SCH	Percent with parent group for MDM	0.00	0.17	0.10	0.1324
	Percent with MDM training	0.50	0.63	0.65	0.4478
	Percent receiving MDM rice on a regular schedule	0.58	0.22	0.35	**0.0129**
HH	Mean number of MDM per week	4.72	4.87	4.81	0.5724
	Mean % of parents satisfied with MDM	0.92	0.90	0.89	0.3251
	Panel C: Anthropometric Measures at Baseline				
Child-level measures aggregated to school level and averaged	Mean % of students with anemia	0.59	0.54	0.57	0.3850
	Mean % with mild anemia	0.24	0.23	0.23	0.8318
	Mean % with moderate anemia	0.34	0.29	0.33	0.3065
	Mean % with severe anemia	0.01	0.01	0.01	0.7241
	Mean child Hb level	11.17	11.31	11.15	0.1882
	Mean student BMI	13.60	13.54	13.78	0.5894
	Mean BMI, anemic students	13.52	13.59	13.68	0.7782
	Mean BMI, nonanemic students	13.62	13.55	13.95	0.4484
	Mean student weight	18.26	18.32	18.38	0.9448
	Mean weight, anemic students	17.36	18.10	17.71	0.3497
	Mean weight, nonanemic students	19.35	19.16	19.35	0.9162
	Mean BMI, girls	13.43	13.47	13.59	0.8722
	Mean BMI, boys	13.74	13.63	13.89	0.4017

Note: P-value corresponds to F-test of the null hypothesis that the three means are the same. Bolded p-values are significant at the 10% level.

Table A4: Comparison of Deworming, non-Deworming schools in high-variation blocks

		Blocks with high IFASP variation		
	Panel A: Demographic Characteristics	Got Deworming	No Deworming	P-Value
School-reported (SCH)	Distance to the block headquarters (km)	20.96	21.98	0.5166
	Primary enrollment	72.60	80.34	0.3015
	Secondary enrollment	29.29	31.66	0.7406
	Number of teachers	2.65	2.28	0.1923
	Percent of schools have a kitchen	0.78	0.63	**0.0472**
	Percent of schools have at least one latrine	0.84	0.87	0.7339
	Percent of schools have sufficient water	0.79	0.65	**0.0526**
Household-reported, aggregated to school level (HH)	Mean % of students are female	0.50	0.50	0.7213
	Mean % of families in a non-disadvantaged caste	0.04	0.05	0.3280
	Mean % of village adults in agricultural work	0.20	0.17	**0.0361**
	Mean % of village adults work in own home	0.27	0.22	**0.0012**
	Mean % of village adults work in others' homes	0.24	0.30	**0.0021**
	Mean % of village adults work as laborers	0.15	0.20	**0.0064**
	Mean % of village adults with no formal schooling	0.55	0.62	**0.0293**
	Mean % of village adults who own a phone	0.32	0.30	0.7103
	Mean % of families that live in high-quality housing	0.09	0.10	0.8925
	Mean % of families that live in low-quality housing	0.76	0.78	0.6574
	Mean % of families with electricity	0.53	0.50	0.5995
	Panel B: Implementer Variables			
SCH	Percent with parent group for MDM	0.10	0.16	0.3031
	Percent with MDM training	0.63	0.48	**0.0747**
	Percent receiving MDM rice on a regular schedule	0.35	0.43	0.3116
HH	Mean number of MDM per week	4.80	4.68	0.2889
	Mean % of parents satisfied with MDM	0.90	0.90	0.6906
	Panel C: Anthropometric Measures at Baseline			
Child-level measures aggregated to school level and averaged	Mean % of students with anemia	0.56	0.59	0.2095
	Mean % with mild anemia	0.22	0.24	0.2567
	Mean % with moderate anemia	0.32	0.34	0.5464
	Mean % with severe anemia	0.01	0.01	0.7747
	Mean child Hb level	11.23	11.15	0.2898
	Mean student BMI	13.70	13.64	0.7182
	Mean BMI, anemic students	13.63	13.57	0.6897
	Mean BMI, nonanemic students	13.79	13.78	0.9551
	Mean student weight	18.31	18.29	0.9313
	Mean weight, anemic students	17.61	17.77	0.6264
	Mean weight, nonanemic students	19.33	19.43	0.8064
	Mean BMI, girls	13.56	13.50	0.7534
	Mean BMI, boys	13.80	13.81	0.9343

Note: P-value tests the difference in the two means, unconditional on block. Bolded p-values are significant at the 10% level.

Table A5: Overall effect of the IFASP on height and weight

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:	Dependent variable: Children's height					
IFASP*Post	0.705	0.620	-0.622	-0.868	-1.902	-2.190
	(0.813)	(0.832)	(1.465)	(1.461)	(2.444)	(2.529)
Deworming*Post	--	--	1.860	2.152	0.010	0.106
	--	--	(1.626)	(1.751)	(0.811)	(1.195)
IFASP*Deworming*Post	--	--	--	--	2.921	3.178
	--	--	--	--	(2.605)	(2.966)
N	1460	1414	1460	1414	1460	1414
Panel B:	Dependent variable: Children's weight					
IFASP*Post	0.564***	0.528***	0.987***	0.980***	1.359***	1.427***
	(0.174)	(0.201)	(0.310)	(0.331)	(0.497)	(0.530)
Deworming*Post	--	--	-0.594*	-0.655*	-0.046	0.041
	--	--	(0.328)	(0.351)	(0.281)	(0.299)
IFASP*Deworming*Post	--	--	--	--	-0.859^	-1.078*
	--	--	--	--	(0.556)	(0.619)
N	1462	1416	1462	1416	1462	1416
School fixed effects?	No	Yes	No	Yes	No	Yes
Added controls?	No	Yes	No	Yes	No	Yes

Note: The dependent variable is child's height measured in cm (panel A) and child's weight measured in kg (panel B). IFASP is a dummy variable that is one if a school reported receiving IFA tablets and zero otherwise. All regressions include an indicator for whether hemoglobin measurement was taken after IFASP implementation and the other relevant main effects of each interaction term. "Added controls" include the following variables interacted with "post": distance to block headquarters, whether or not a school has a kitchen, the percent of parents satisfied with MDM implementation, the percent of families employed in housework outside the home, and the percent of families in a non-disadvantaged caste. Standard errors clustered by school are in parentheses. Significance at the 0.15, 0.10, 0.05, and 0.01 levels indicated by ^, *, **, and ***, respectively.

Table A6: Hemoglobin levels to diagnose anemia at sea level (g/dL) [WHO 2011]

Population	**Non-Anemic**	**Mildly Anemic**	**Moderately Anemic**	**Severely Anemic**
Children 6-59 months old	11.0 or higher	10.0-10.9	7.0-9.9	less than 7.0
Children 5-11 years old	11.5 or higher	11.0-11.4	8.0-10.9	less than 8.0
Children 12-14 years old	12.0 or higher	11.0-11.9	8.0-10.9	less than 8.0